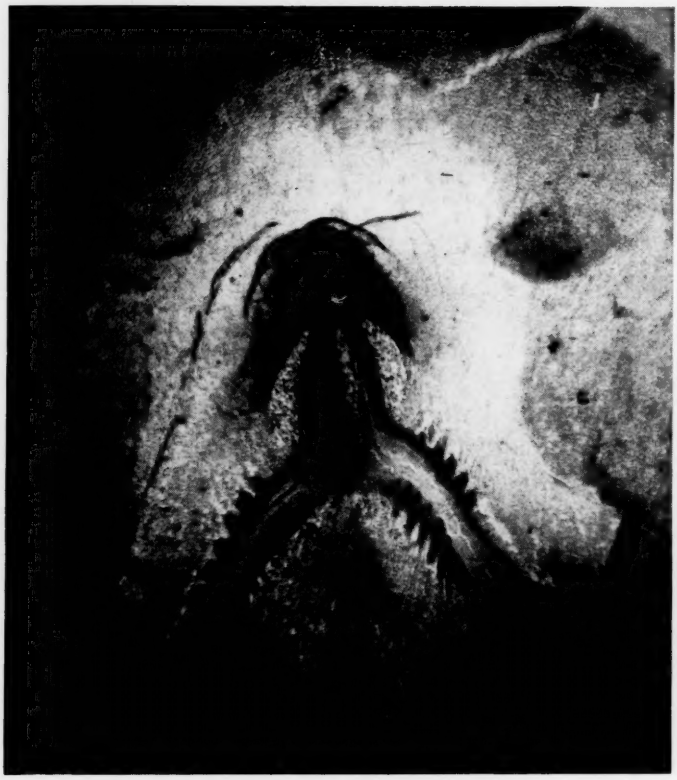
The Journal of HEREDITY



LIFE BEGINS FOR A KATADIDYMUS
(SEE PAGE 371)

Differential Birthrates in 1800
Promoting the Four-Child Family
A Glossary of Medical-Genetic Terms
Five Generations of Pits in the Ears
Differences in a Reciprocal Cavy Cross

VOLUME 31 SEPTEMBER, 1940 NUMBER 9

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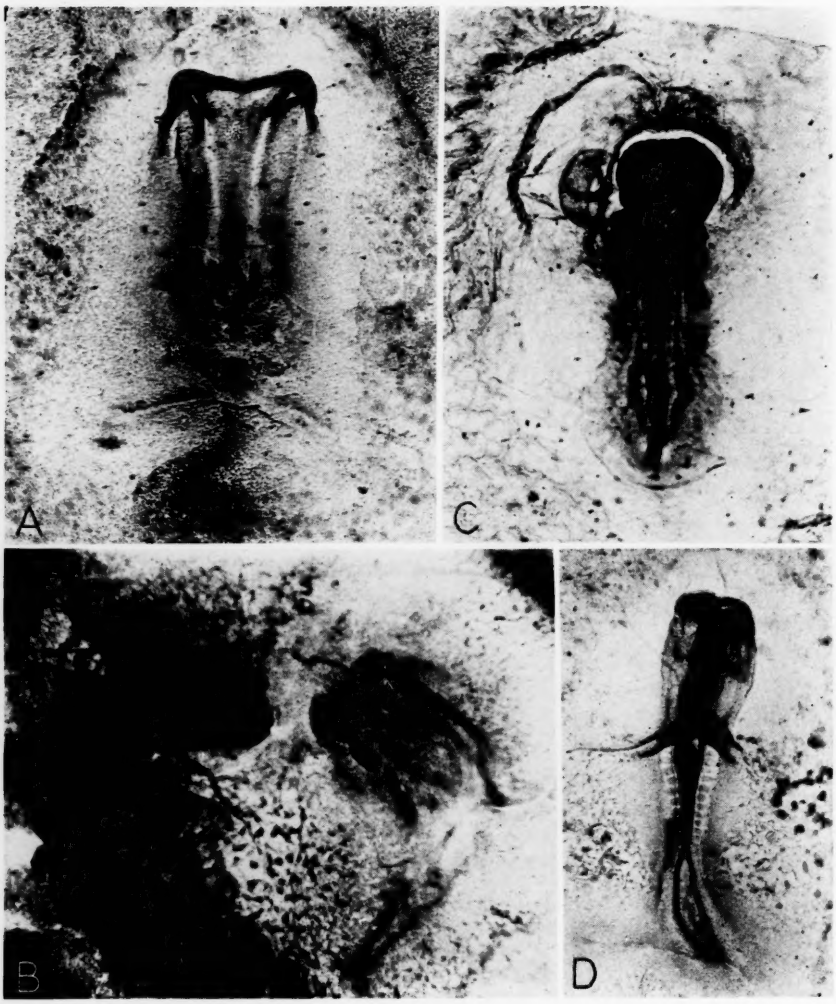


TWIN EMBRYOS

Frontispiece

A—a twin embryo almost certainly due to the nearly complete splitting of a single embryonic axis. This would probably result in conjoined twins if both axes developed (Case 1). *B*—a rare type of multiple embryo, representing a triplet or quadruplet condition (Case 2). *C*—a "two-headed" embryo with a single heart (Case 3). *D*—an embryo with a distinct bifurcation of the fore-brain region, and a twinned spine, suggestion spina bifida (Case 4). These cases all represent the splitting of part or all of a single embryonic axis, such splitting taking place so late in development that double monsters would result, rather than separate individuals.

TWIN AND TRIPLET CHICK EMBRYOS

H. H. NEWMAN
Hull Zoological Laboratory, University of Chicago

SEVENTEEN years ago, in *The Physiology of Twinning*,[2] I summarized the previous literature on twinning in birds and described some new and unusual cases of my own. On the basis of material then available I distinguished five types of monozygotic chick twins as follows: (1) those arising from the early, complete fission of the blastoderm, giving rise to two separate blastoderms on one yolk; (2) those derived from two embryonic axes on a single blastoderm, the two axes resulting from double gastrulation; (3) those derived through complete or partial longitudinal fission of a single embryonic axis. In addition to these three primary types of origin, two secondary types of chick twins were recognized: (a) those derived from secondary partial fusion of two originally separate embryos; and (b) those types of double monsters belonging to any of the four types just listed in which one twin, or component, has been partially or completely suppressed by the dominant autosite and reduced to a parasite. The last type of twin is called autosite-parasite.

Of these five categories of chick twins only the third type, those derived from the complete or partial fission or duplication of an originally single embryonic axis, has failed of general acceptance. Stockard, Gemmill, and others always maintained that all double monsters are the product of partial fusion of separate embryonic axes and were inclined to rule out the possibility that any of them could arise through fission of a single axis.

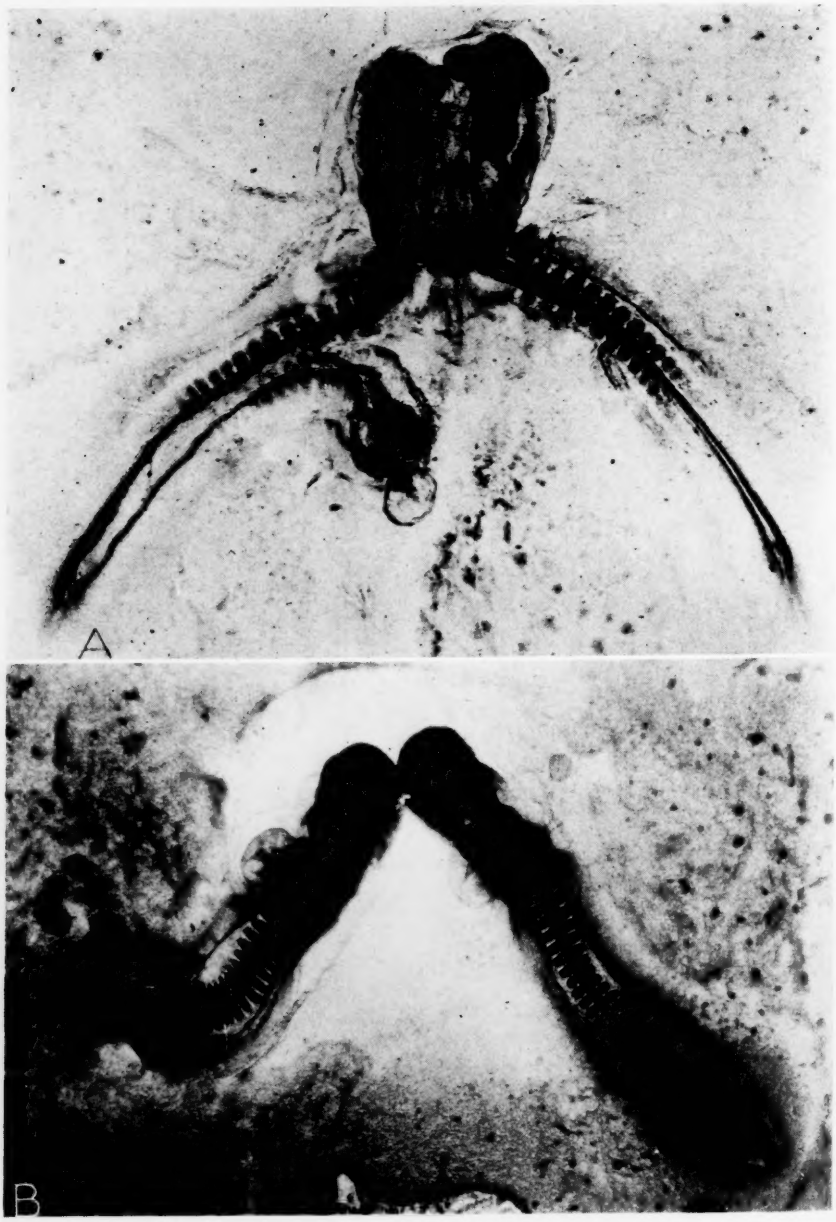
The purposes of the present communication are first, to record and illustrate with good photographs taken by Mr. Kenji Toda, our staff artist, a number of new cases of chick twins and triplets that have accumulated since my last publication on the subject; and second, to rediscuss the problems of the origins and causes of twins in birds and of one-egg twinning in general. I shall first describe the various new cases and shall then discuss their bearing on twinning problems.

Case 1. This case (Frontispiece *A*) is almost certainly the result of an almost complete fission of a single embryonic axis. The original axis of gastrulation coincides with the long axis of the blastoderm and there are no indications that the two axes have been derived from two distinct regions of gastrulation. The condition of the two heads is about that expected in a normal embryo of 23 hours, but no mesoblastic somites have as yet been clearly differentiated, whereas in a normal embryo of 23 hours five or six pairs of somites are present. Hence there are good evidences that this twin embryo is already retarded. Unfortunately I have no record of the actual developmental age of his specimen.

As to the probable condition that such a twin embryo as this might attain we can only offer a conjecture, but it seems certain that completely separate twins would be impossible of attainment, for the two axes are too close together to permit independent growth. At best, unless early deteriorative changes set in, we might expect from such a condition as this a type of closely conjoined twins with extensive internal and less extensive external duplication of organs and systems.

Case 2. This is a rare type of multiple embryo (Frontispiece *B*) which represents at least a triplet, if not a quadruplet, condition. There can scarcely be a doubt that the double embryo on the right is the result of a nearly complete longitudinal fission of a single axis. The embryo on the left seems also to have undergone partial fission of the anterior end. None of the embryos in this group are even approximately normal and their chances of developing up to advanced stages would have been slight. This photograph was sent to me some years ago by Dr. T. H. Bissonnette, to whom I am also indebted for two others.

Case 3. This stunted embryo (Frontispiece *C*) was discovered by a student who was at once struck by its odd appearance. It was supposed to be about a 48-hour embryo, but is obviously greatly retarded. It is much too broad for its length and in some regions the somites are distinctly crowded. Apart from these abnormal features, the embryo is definitely bifurcated at the anterior end, but the heart and post-cephalic region are single. There is no possibility that this embryo could have arisen through the fusion of two separate axes.



FISSION VERSUS "COLLISION" OF AXES

Figure 1

A—a triple monster apparently due to the fission of a primary axis, and a secondary fission of one of these "twins" (Case 5). *B*—When two axes meet at less than 90 degrees they force each other out of shape as secondary fusion ensues (Case 6).

Case 4. This embryo (Frontispiece *D*) seems to be rather more normal than other cases so far dealt with, but there is distinct bifurcation in the fore-brain region, while in the posterior region there is a condition that would probably result in *spina bifida*. This is surely a fission rather than a fusion case.

Case 5. The embryo here shown (Figure 1*A*) was sent me some years ago by a student in another university, whose name I cannot recall. If he recognizes the case, let me take this opportunity of thanking him for sending me the slide. Unfortunately, one of the students in my class somewhat damaged the specimen by pressure of the high-power objective, so that it is not quite so pretty as it originally was. This specimen is rather difficult to interpret, but I believe it must be regarded as a case of complete longitudinal fission of a single original axis to form two complete embryos whose head regions lie parallel, but whose posterior regions widely diverge. After the first fission the left embryo has evidently undergone a second anterior bifurcation to produce a normal head end and a subnormal head end. This second head end, however, has a well-developed heart of its own. It is this deformed head end that was partially crushed and somewhat separated from the common trunk region, as the discontinuities in the photograph show clearly. Originally this accessary head was as strongly attached as is the other head.

There seems to be no other reasonable interpretation of the anterior duplicity of the left-hand twin than the one just offered. Moreover, the duplicity extends much further than the head and might have been extended throughout the entire length.

The real problem about this specimen has to do with the question of the mode of origin of the main pair of twin embryos: whether they originated as two separate axes by double gastrulation or as the fission products of an originally single axis.

Arguments against the double gastrulation alternative are as follows: (a) Whenever two separate embryonic axes originating far apart grow toward the center of the blastoderm, they usually meet and fuse on contact. (b) When they meet at an angle of 90 degrees or over, there is always considerable crumpling and distortion of one or both axes. (c) The two anterior ends of this specimen lie parallel and both are normal or nearly so. (d) In order for the two axes coming together at an angle of over 90° to have bent each other into the positions seen in this specimen they must of necessity have come strongly in contact, but these axes are not in contact at any point. Even the inner optic vesicles of the two individuals are close together but not fused.

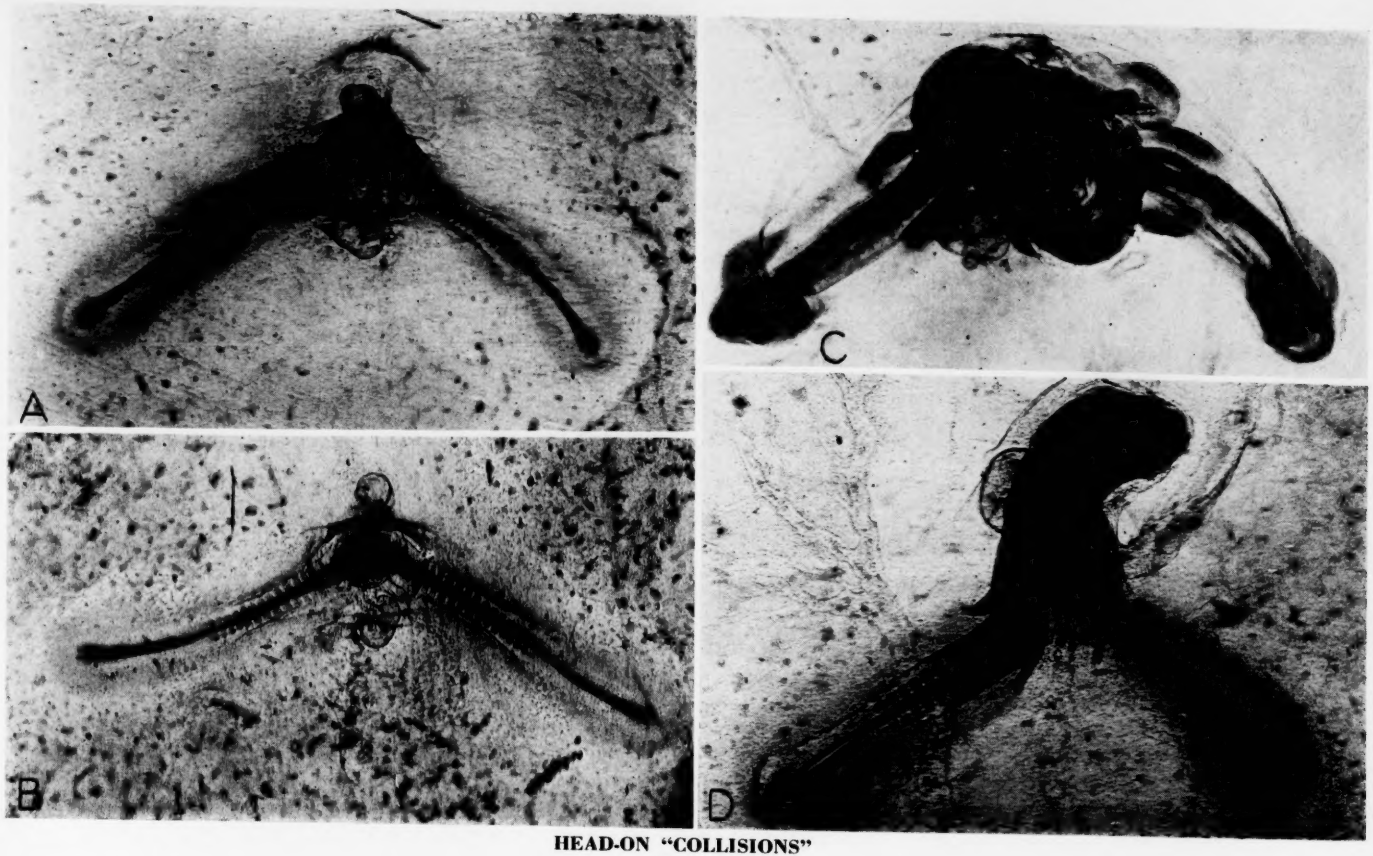
In view of these evidences I am forced to conclude that this triple monster is the product of the complete fission of a single primary axis, followed by a secondary less complete anterior fission of the left component. Had this specimen developed to a hatching stage it would probably have turned out to be a double monster with a very broad head involving secondary fusion of brains and a median double eye. The posterior parts would have been separate and duplicate with probably four legs and four wings. The left component would probably have had an additional abnormal head attached to its right side with *spina bifida* evident in the posterior region.

Case 6. This specimen (Figure 1*B*) shows clearly that when two separate axes meet at even less than a 90° angle they come in contact and force each other to bend out of shape. The left-hand individual is severely bent in the middle trunk region with considerable displacement of somites. The right component also shows some distortion, but has suffered much less than the left. Undoubtedly, had the specimen gone on to a more advanced stage, there would have resulted some fusion in the head region, for the two heads are already fully in contact in the optic region. This specimen affords strong support to the interpretation offered for Case 5.

Cases 7 and 8. (Figure 2*A-B*) are almost identical and are similar to those shown in figures 37 and 38 in *The Physiology of Twinning*. They are evidently the result of head-on collisions of two separate axes originating from double gastrulation. The two hearts are forced one to an upper and the other to a lower position. The brains of the two components are crushed together and extensively fused. It is difficult to imagine the type of combined head that would have eventuated had the specimen lived to an advanced stage. Possibly the next specimen will aid in visualizing what might have come to pass.

Case 9. This specimen (Figure 2*C*) is in an advanced limb-bud stage. At an earlier stage it may have resembled the specimen shown in figure 38 in *The Physiology of Twinning*. Here both component axes are badly distorted through mutual pressure, the two hearts are crowded to opposite sides of the central mass, the fore- and mid-brains are fused and seriously abnormal, but the hind-brains are but little affected. This specimen, had it been allowed to develop further, would doubtless have had a single very abnormal head but two separate trunks. The right component, however, already shows signs of regressive changes, for the somites are very indistinct. Probably the anterior part of the trunk would have been fused externally, but there would have been duplicate hearts, circulatory systems and other viscera.

Case 10. This specimen (Figure 2*D*) is rather difficult to interpret. It may be either a case resulting from the anterior fusion of two originally separate axes, or a case of incomplete fission of a single axis. In favor of the latter interpretation is the fact that there is but a single heart, whereas in all other cases resulting from the fusion of two axes



HEAD-ON "COLLISIONS"

Figure 2

A-B—almost identical cases resulting from the head-on collissions of two separate axes originating from double gastrulation (Cases 7 and 8). *C*—the fore-brain regions badly distorted by mutual pressure, but with two hearts (Case 9). *D*—Effects of differential growth rates of the two axes, which may have originated either by double gastrulations or by fission of a single axis (Case 10).

the two hearts persist and seem to have no tendency to fuse. The anterior region is almost completely double with respect to brain and spinal cords, but there is some fusion, probably due to secondary crowding, of the fore-brains. The curious bent position of the anterior region is obviously the result of unequal development of the two twin primordia. The left component has grown more rapidly than the right and has pushed the right component over. It also is evident that the left component has assumed a decided physiological dominance over the right, and that the latter is already showing signs of marked regression. Since there is but a single heart, it is probable that this specimen would have eventually developed into a deformed autosite-parasite case, with the right component reduced to a dependent extra pair of legs supported by the circulatory system of the autosite. The head end of the monster could hardly have been restored to normality. On the whole, the evidences favor the fission rather than the fusion origin of this specimen.

Case 11. This embryo (Figure 3) is obviously a clear case of posterior duplication, or fission. The two trunk regions are in the 7-8 somite stage, though the somites of the right component are somewhat abnormal. The head region, especially the fore-brain, is considerably retarded as compared with the trunk regions. As yet the heart is not visible. The head fold of the amnion is only about as far along as one would expect in a three-somite embryo. There are then in this double monster specimen clear indications of developmental retardation in the head region.

It is also clear that this case is not one that could have resulted from fusion of two separate axes, for there is not the slightest indication of duplication in the head region, a condition that is always present in embryos that result from the contact and fusion of two axes. In brief, this specimen can have resulted only from posterior bifurcation and in on other way.

Case 12. This specimen is one which has been preserved in alcohol. Because of its rather large size and because it has been crowded into a museum jar too small for it, it has stiffened into a badly distorted shape ill adapted for photographic purposes. Hence no photograph will be presented. The specimen had either hatched or had passed the hatching period in the egg shell, for the feathering is more advanced than would be expected in a newly hatched chick. The particular interest attaching to this specimen is that there is a single very abnormal head and two complete trunks with two pairs of wings and legs. The head is a typical cyclopian. The single very large eye on top of the head has seemingly suppressed the upper jaw and reduced the nostril region to a short trunk-like structure. Cyclopia is generally regarded as a consequence of growth depressing factors and this condition, when associated with twinning, inclines one to believe that both twinning and cyclopia have had a common cause, namely, some early developmental retardation.

Summary of Cases

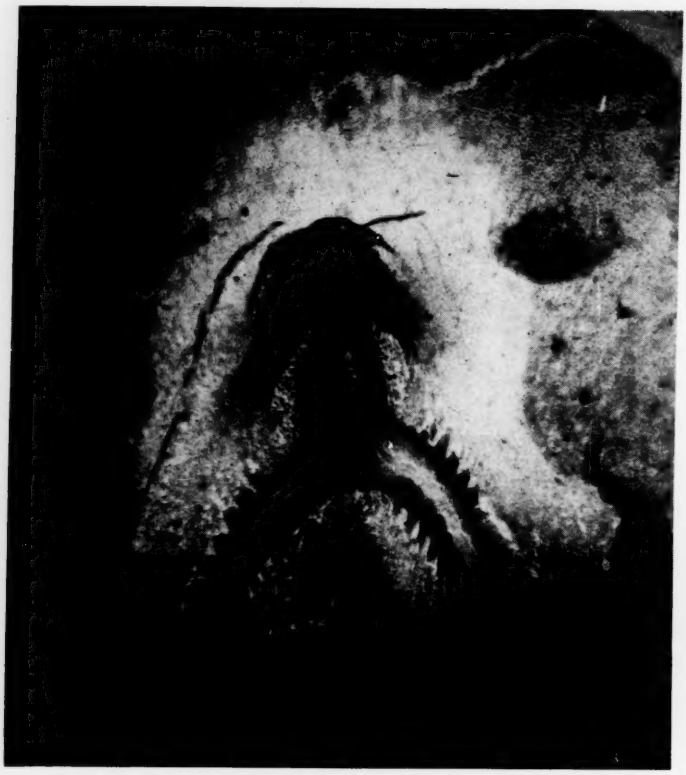
In addition to the cases herein discussed and illustrated, I have in my possession five other specimens of chick twins that have come to me from various sources. All of these are single anteriorly and bifurcated posteriorly. Three of these are so nearly duplicates of the embryo shown in Figure 3 that it seems superfluous to describe or illustrate them. Incidentally it should be said that the katadidymus is the commonest type of twin in birds.

The remaining two twin specimens in my collection are advanced embryos close to hatching. They have been packed too closely in small museum jars and are therefore distorted so badly that they are quite unsuitable for photographic representation. In one the head is single and normal, there are only two normal wings, but there is an additional pair of legs somewhat loosely attached to the lower abdominal region. It seems probable that this condition arose from an earlier stage similar to that shown in Figure 3, that one of the posterior ends underwent partial regression and that only the legs succeeded in continuing to grow and differentiate. This might be expected in view of the well-known fact that limb buds possess a high degree of autonomy in development and will grow to almost full size even when grafted into highly foreign regions of the host. The other specimen is very similar to the one just described, but the upper beak is partly bifurcated.

The Viability of Chick Twins

Much new light has been thrown on the viability of the various types of twins and double monsters by the recent study of Komai and Nakamura.[1] These investigators collected from Japanese zoological laboratories and commercial chick hatcheries 80 specimens of chick twins and double monsters at stages just before or just after hatching. Among these there was only one pair of "perfect

C—the fore-brain regions badly distorted by initial pressure, but with two hearts (Case 9). D—Effects of differential growth rates of the two axes, which may have originated either by double gastrulations or by fission of a single axis (Case 10).



DUPLICATION OF AN AXIS

Figure 3

Since there is one head, and with no indication of fusion, this partial twin must have arisen by partial fission of a primary axis. It would probably have developed into a monster with one head, and two fairly complete bodies (Case 11).

twins," consisting of two nearly equal-sized normal chicks "united by an umbilical cord". They are regarded as monozygotic. It seems probable, however, that they have been derived from two blastoderms on the same yolk. The fact that the down feathers of the two individuals are slightly different in color may mean that there were originally two egg nuclei that were fertilized by different sperms.

None of the specimens found has a badly distorted or crumpled head region. This seems to mean that embryos that have undergone collisions such as those shown in Figure 2 do not survive up to late embryonic stages.

Seven specimens in the Komai and Nakamura collection showed more or less extensive anterior duplication. Most of these had bifurcated beaks and a third median eye. One specimen had an oversized head with an enlarged but symmetrical brain and double upper beaks, but separable spinal cords and neck vertebrae. This may represent a regulated

condition following fusion of two axes about as close together as those shown in Frontis. *A*. The great majority of chick twins that are viable up to or beyond hatching are posterior duplications (katadidymi), three specimens being symmetrical, the rest asymmetrical and consisting of a well-developed autosite and a much deformed parasite. The usual parasite component consists mainly of an extra pair of legs and pelvic girdle which may be firmly or loosely attached to the autosite, sometimes only by "an umbilical cord".

Most of these so-called katadidymi probably arose from posterior bifurcation of a single axis, but those attached by the yolk stalk only must have arisen either from two distinct blastoderms or from two axes that had resulted from double gastrulation.

Discussion

In none of the specimens of chick twins, including early embryos and late, is there any evidence that *symmetrical* double monsters (cosmobia) are the result of fusion of originally distinct embryonic axes. When such fusion occurs through meeting of two axes head-on in the middle of the area pelucida, so much crushing and distortion occurs that symmetrical double monsters with single, normal head and bifurcated posterior regions would never result. It is our present conviction that all anadidymi and nearly all katadidymi are the result of the partial fission, or complete fission followed by secondary partial fusion, of a single embryonic axis. The extreme rarity of separate one-egg twins in birds is probably associated with the fact that in the confined space within the egg it is very difficult for two embryos arising from one blastoderm, or even for two arising from two adjacent blastoderms, to avoid fusion of at least the yolk blood vessels. Such fusion may result, as in human one-egg twins, in unequal exchange of embryonic blood resulting in the premature heart death of one twin and its reduction to a parasitic condition.

In this paper I have supported with additional evidence my earlier view, that one common mode of twinning in birds is that of the complete or partial fission of an originally single embryonic axis. The other two methods of twinning, namely those involving origin from two separate blastoderms and those from double gastrulation, stand without need of defense.

Causes of One-egg Twinning in Birds

Stockard[3] advanced the theory that twinning in birds is a consequence of the occasional premature laying of eggs before the completion of gastrulation, followed by cooling and consequent developmental arrest. Experiments involving the artificial forcing of premature laying failed to support this view, for no twinning occurred in these prematurely laid eggs. In many experiments on fishes and echinoderms it was found necessary to arrest development at a period much earlier than gastrulation in order to induce twinning. The best results were obtained when the fertilized eggs were inhibited even before cleavage had begun or, at the latest, during early cleavage.

In view of these facts, it seems necessary to conclude that in birds some inhibiting influence must affect the eggs high up in the oviduct and that the consequences of such inhibition appear much later in a tendency for the embryo to lose unity and duplicate itself in some way or another. It is even quite possible that the cause of early inhibition is genetic, but we have no evidence to support this possibility.

That twinning in birds is a consequence of early developmental arrest is evidenced by the very common occurrence of retarded development in twins. The specimens shown in Frontispiece and in Figure 2*A*, *D*, etc., show distinct signs of developmental retardation of one or both components. This condition is especially marked in Frontispiece *B*. Also the association of a cyclopic head with a bifurcated trunk in one of our advanced twin chicks (Case 12) seems to point to a common cause for the two conditions.

Comment on the Retardation Theory of One-egg Twinning

The general theory advanced in my *The Physiology of Twinning* and further elaborated elsewhere had its origin in the fact that in the nine-banded armadillo the very early embryo, at an inner-cell-mass stage, comes to a complete developmental stop, lying free in the uterus for over two months before attaining placentation. When finally placentation occurs, twinning quickly follows. It was natural to explain twinning as the result of the long period of embryonic quiescence. When, however, various writers called attention to the fact that several other mammals, including badgers, roe deer and some bears, also have a prolonged period of early embryonic quiescence and belated placentation without any resulting twinning, many zoologists lost faith in the developmental-arrest theory of one-egg twinning. I, however, have never felt that these negative observations about other mammals prove anything about the causes of twinning in the armadillo, man and other vertebrates that do exhibit one-egg twinning. In the first place, no one knows with respect to these other mammals at what stage of development the embryonic quiescence begins. If it does not begin at a very early stage or at least before the onset of gastrulation, complete twinning would not be expected. Until, then, it is shown that the quiescent embryos of these mammals are in a stage susceptible of twinning, they furnish no evidence against our theory as applied to the armadillo, birds or man. In the second place, one writer claims that because in the armadillo twinning is specific, it must depend solely upon genetic, not upon any environmental factors. Of course twinning in the armadillo is hereditary, but that does not mean that embryonic quiescence has nothing to do with twinning. In all probability what is inherited is some condition of the egg or the uterus or both that brings about embryonic quiescence, and this in turn causes twinning. Moreover, it may well be that the armadillo inherits a strong tendency to undergo twinning when retarded, while other forms that do not twin lack this inherited tendency.

In birds there is apparently no special genetic tendency toward one-egg twinning, for twinning is extremely rare. Hence the causes of twinning are, in all probability, purely environmental.

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Pictures of Data

IN 1805 William Playfair credited his brother John with the proposition "That whatever can be expressed in numbers, may be expressed in lines." William Playfair used this principle to show graphically the commercial rise and fall of nations from 1500 B. C. up to his own time. Graphic presentation, Mr. Brinton tells us, in his most interesting book* on that subject, that it antedates William Playfair many centuries in its crude beginnings. Since 1805 the presentation of statistics and other factual data by means of graphs has made tremendous progress, as reference to any number of books. magazine articles and annual reports will tell us.

In our chosen field of heredity, the graphing of geneological data goes back some five thousand years, if the prehistoric horse pedigree published in the Journal in 1935 represents approximately the beginnings of that process. That early graph is not included in Mr. Brinton's history, though a number of modern genealogical charts are there presented, two from our Journal. Other biological and demographical material presentations are also given considerable space.

Anyone who is faced with the problem of presenting data graphically, will find this book most valuable in giving under one cover a tremendous variety of methods which have been used with varying degrees of success—not only examples, but horrible examples are included. It also includes a section on photographic processes and on the various processes of reproduction through printing, lithography, offset, etc. It is unique and will be invaluable for those who require such a compendium—R. C.

*Brinton, Willard Cope. *Graphic Presentation.* Pp. 512. 676 illustrations. $5.00. Brinton Associates. New York, 1939.

EAR PIT AND ITS INHERITANCE

Fistula Auris Congenita, described in 1864, still a genetical and embryological puzzle

THORDAR QUELPRUD
The University, Oslo-Blindern

IN the JOURNAL OF HEREDITY for 1939 Whitney[18] described three generations of a family with ear pits at the proximal end of the upper part of the helix. He has found the pit both on one or both sides and reports that "in inheritance the pit behaves as an irregular dominant," concluding that "these observations corroborate the findings of Kindred." Kindred[7] has described a family with ear pit in four generations; ten individuals are affected, all on the left side. "Judging from the manner of its appearance the marking is neither dominant nor recessive, but must fall into the intermediate doubtful class of incomplete dominance."

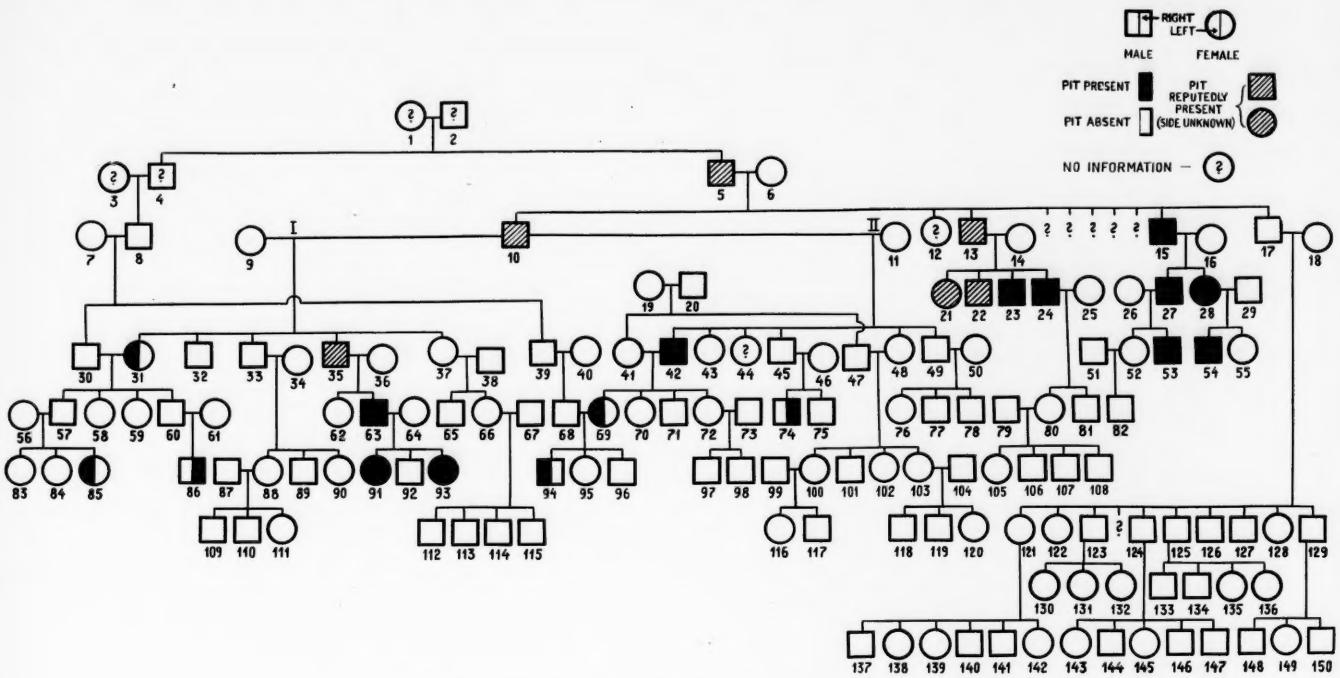
In spite of the lack of references in the above mentioned reports the two authors are probably aware that this ear pit corresponds in every respect with the pit or fistula known as *Fistula auris congenita,* which is described several times in the literature. The first complete description was published by Heusinger in 1864, followed by a number of reports of which mention should be made of Urbantschitsch,[17] Gradenigo,[3] Stannus[14] and Onodi.[9]

The location varies somewhat but the pit is usually found at the anterior side of the helix as is shown in Kindred's and Whitney's figures and in our Figure 5. It may sometimes appear as a true fistula with a canal from 1 to 15 mm. in length or it may be a tiny pit no larger than a pinhead and may easily escape observation. Especially during childhood there is often a milk-like secretion from the canal, consisting mainly of cell detritus. This may be malodorous. The canal may in some cases become cyst-like, occasionally storing up the secretion and forming a cyst which is visible under the skin. In rare instances where the secretion is not discharged regularly through the canal a slight operation is necessary. Fistula auris congenita, which is found in both sexes may be present on one or both sides. Cases of a true fistula on one side and a tiny pit on the other have also been seen. The fistula must be regarded as a benign formation of little clinical importance but is of interest to anatomists, embryologists and human geneticists.

Theories of Origin

As is well known, the auricle arises from the region of the first branchial cleft, so that a part is of mandibular and a part of hyoidal origin (cf. inter al. His[6] Streeter[16] and Wood-Jones and I-Chuan.[19] Especially after Hammar's investigation (1902), most of the external auditory meatus must be regarded as of secondary origin, formed as an indentation from the region of the first branchial cleft.

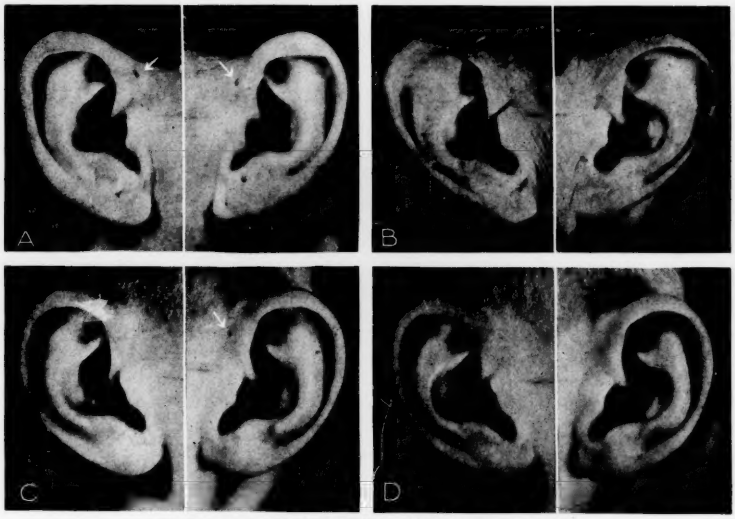
Many investigators claim that the fistula represents a vestige of the first branchial cleft. In spite of the fact that no definite connection between the fistula and the tympanic cavity has been observed, this is no contradiction of the foregoing assumption. Others (also Whitney) believe that the fistula is a secondary formation as a result of incomplete fusion of the so-called auricular hillocks of the embryo. Wood-Jones and I-Chuan[19] state that "the hillocks themselves, even as pictured by these investigators, are of such low elevation that it is hardly possible to conceive of a pit or a fistula being formed at their sites of junction." Personally I would like to add that especially in the case of deeper fistulas this type of origin seems most improbable. Moreover these two authors,



A PEDIGREE OF EAR PIT

Figure 4

Fistula auris congenita traced for five generations, based on investigations of G. V. Royk-Lewinski.



EAR PITS IN MOTHER AND TWIN SONS

Figure 5

Fistula on both sides in mother (*A*), the father being normal (*B*). In their identical twin sons one member of the pair has a fistula on the left side only (*C*), the other is normal (*D*). The mother's ancestry had no pits for two generations.

in contrast to many other investigators, believe that the mandibular part of the ear consists only of the tragus and the foremost part of the external auditory meatus. In support of their theory they use the argument that the ear fistula varies in its location but is always found along a definite curved line (cf. their Figure 1) which represents the closed region of the first branchial cleft, which in certain instances fails to fuse completely and forms the fistula. They refer also to their embryological investigations, to the pre-auricular appendages, to monsters where the lower jaw is absent but the external ear with the exception of the tragus is present, and finally to the innervation of the ear according to most clinicians. The hypothesis is attractive but we shall leave these speculations and consider the inheritance of the fistula.

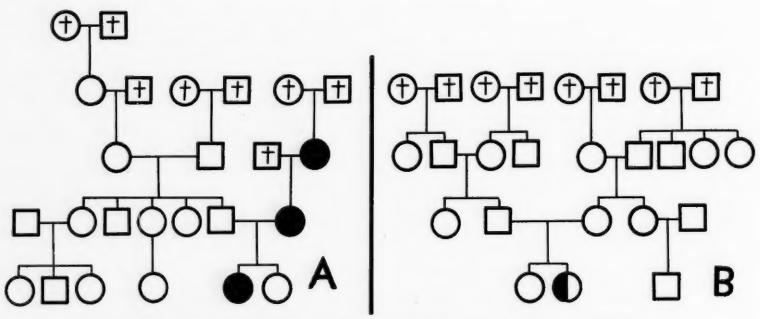
Inheritance

The assumption that Fistula auris congenita is inherited was made by Urbantschitsch in 1877, who described a family in which we would today consider the appearance of the fistula as an irregular dominant. Larger families were also described by Paget,[10] Hartmann,[4] Kratz,[8] Eyle[2] and others, all of them pre-Mendelian reports in which the inheritance of the character was emphasized. In 1921 Kindred published his left ear pit family, in 1928 Starkenstein reported on two large families which showed regular dominance, in 1934 Quelprud published a short report on the variability and dominance of the fistula and finally, in 1939 we have Whitney's family.

Of published twin cases there is one of Siemens[13] where the identical diagnosis was not definite and one of Brauns[1] concerning a pair of identical twins. In both cases one of the pair had the fistula and on one side only.

As a step in an extensive twin and family investigation, which I have made, concerning the variability and genetics of the external ear, Fistula auris congenita was one of the objects of my observations. The complete results of this investigation will be published later.

First I will discuss the genealogy pre-



TWO PEDIGREES FROM A VILLAGE POPULATION

Figure 6

A — Daughter, mother and grandmother with fistula on both sides. *B* — One single affected individual (left side only) where neither parents, grandparents nor their siblings are affected. † = dead before investigation.

sented in the pedigree, Figure 4 including 150 individuals. The table is the result of extensive investigations made by Miss G. V. Royk-Lewinski, Berlin-Dahlem, and I am indebted to her for permission to use the data for publication. In 1932 Geheimrat H. Virchow called attention to this family after a lecture given by the author and presented a picture of the fistula. Royk-Lewinski's investigation was carried out at his suggestion.

We see the following from the table:

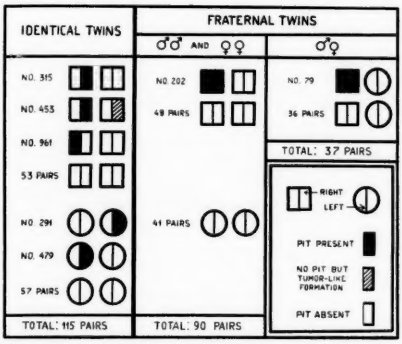
A man, No. 5, who according to his children and grandchildren had the fistula (side not known), had ten children. Six of these must be reported as uncertain as there are no reliable observations for them. Of the other four children Nos. 10 and 13 had the fistula according to the next generation, No. 15 was definitely affected and No. 17 was normal. No. 10 was married twice. In his first marriage (with No. 9) he had five children. Of these, one daughter, No. 31 had the fistula on the left side and it appeared again in two of her grandchildren, No. 85 on the left side and No. 86 on the right. A brother of No. 31, No. 35 was said to have had the fistula which appeared again on both sides in his son No. 63 and in two of the son's daughters, Nos. 91 and 93. In his second marriage (with No. 11) No. 10 had six children, of which one died very young (No. 44) and was not examined. Of the other children only No. 42 had the fistula (on both sides), which appeared again on the left side in his daughter No. 69 and the daughter's son No. 94. A brother of 42, No. 45, who was normal, had a son, No. 74, who had the fistula on the right side. No. 13 had four children Nos. 21 and 22 who died young, but had the fistula according to their brothers, and Nos. 23 and 24 who definitely had the fistula on both sides. No. 24 married and had children but the fistula did not appear again in any of his descendants. No. 15 had the fistula on both sides and it reappeared on both sides both in his children (Nos. 27 and 28) and grandchildren (Nos. 53 and 54). No. 17's nine children are normal as was their father and 21 grandchildren and their children are all normal where observations have been made.

In this family the members were well aware of the fistula and like the family published by Eyle they called the pit the family coat of arms. Therefore it is likely that the descriptions furnished by the family members are correct.

Taking the family as a whole there can be no doubt that one and the same hereditary factor is responsible for the anomaly and that it is incompletely dominant as its manifestation is extremely variable.

In comparison it is interesting to examine the results of an investigation on the appearance of the fistula in a village population in Hessen and in a twin population from Berlin. From Table I, we see that it is present in 1.7% of the Hessen population and in 1.5% of the twins. The fistula appears in both sexes and when present on one side only may be right or left.

Of the total village population examined there were 161 families with a total of 358 children. In 153 of these families



FISTULA AURIS CONGENITA IN TWINS

Figure 7

The figure summarizes the findings on 115 identical pairs (56 ♂ ♂ and 59 ♀ ♀) and on 127 fraternal pairs of which 90 were of like sex (49 ♂ ♂ and 41 ♀ ♀) and 37 pairs of opposite sexes.

with 340 children the anomaly was present neither in parents nor children. The other eight families are presented in Table II.

In no case were both parents affected. In the four families where one of the parents was affected it appeared again in the children in No. 46 only. The mother and one of the two daughters had the fistula on both sides. The mother's mother was also affected, on the right side there were even two openings, 4-5 mm. in front of the ordinary fistula there was a smaller one. The mother's father was dead (See Figure 6*A*). In four other families where both parents were normal, four out of seven children had the fistula. An example of this type of family where neither the parents nor grandparents are affected is given in Figure 6*B*. None of these families is in disagreement with the interpretation that the fistula is due to an incompletely dominant hereditary factor.

In Twins

While one may safely assume that one and the same gene is responsible for the fistula in the village population, the same cannot be said of the twin population which is probably more heterogenous. But this is always the case in studies of large twin series; nevertheless the results of such examinations are valuable in solving problems in human genetics.

The twin investigations which were carried out in the K. W. Inst. f. Anthropol., Berlin-Dahlem, include 115 identical pairs and 127 fraternal pairs (of which 90 are of the same sex) (Figure 7). Among the identical (monozygotic) twins the fistula is present in four pairs while the other 110 are normal. None of the four pairs is concordant. In four of the pairs the fistula is present in one twin on one side, while the fifth pair, male twins (No. 453), are possibly concordant. Here one of them has the fistula on the right side, the other has no true fistula but a tumor-like formation which might be a closed cyst. Among the fraternal (dizygotic) twins the anomaly was found in only two cases, in both instances in one member only and on both sides.

This result is not surprising. The very fact that the fistula so often appears on one side only is corroborated by the mode of occurrence observed in identical twins. The studies on twins supply the family investigations and support the theory of irregular dominance. Since identical twins are not concordant as regards the anomaly, its variable manifestation can hardly be due to genetic factors.

Especially interesting is the following family which includes one of the pairs of twins examined (No. 961). A woman has the pit on both sides (Figure 5*A*), both her parents are normal, as are her maternal grandparents; her paternal grandparents are dead and we have no information concerning them. The woman's husband has ten siblings who are normal like himself (Figure 5*B*). The anomaly is not present in his parents, grandparents or in 19 nieces and nephews. This couple has three sons. The oldest is normal, the two others are identical twins of which one has a fistula on the left side, the other is normal (Figure 5*C* and *D*). Regarded in the light of all the other instances of the fistula, we have here the following situation: An individual whose parents are normal has the anomaly on both sides while the factor for this anomaly in her identical twin

sons manifests itself in only one member of the pair and on only one side,—a very clear example of irregular dominance.

The possibility cannot be excluded that this type of ear fistula might suddenly appear from some other cause than a hereditary factor. But otherwise its mode of inheritance seems to be quite clear although it is not possible to affirm that the anomaly is caused throughout its entire geographic distribution by one and the same hereditary factor. It represents a dominant character of labile development. No certain cases of homozygosity are known. It should however be mentioned that Hartmann[4] (p. 56) has described a family where both parents had the anomaly and where there is a possibility for homozygosity among their children. They had three sons, all had the fistula and one of these had five children, all of which were affected. Because of its relative rarity and its peculiar dominance the fistula may be useful in determining cases of doubtful paternity.

Summary

The ear pit described by Kindred[7] and Whitney[18] is identified with fistula auris congenita, described by Heusinger[5] in 1864. The literature of the embryology and genetics of the fistula is reviewed.

In connection with the data hitherto published, the author contributes some new data from family and twin studies. A larger family, consisting of 150 individuals confirms the irregular dominance of the anomaly; investigations on a village population (751 individuals) and of 242 pairs of twins support this interpretation.

It cannot be definitely stated that the fistula throughout its geographical distribution is due to the same gene, but its labile developmental tendency which is expressed by variation in manifestation, seems in most cases to be characteristic.

TABLE I. Fistula auris congenita in a village population, and in a twin population. + = ear pit present, − = ear pit absent, R = right, L = left side.

	R L + +	R L + −	R L − +	R L − −	Total	Affected n	Affected %	
Village ♂	3	0	1	369	373	4	1.1	1.7
population ♀	3	3	3	369	378	9	2.4	
Twin ♂	2	2	1	239	244	5	2.0	
population ♀	0	1	1	229	231	2	0.9	1.5
Total	8	6	6	1206	1226			

TABLE II. The eight families of the village population in which at least one member was affected. + = affected, − = normal. (153 families with a total of 340 children had no affected members.)

Family No.	Parents ♀	Parents ♂	Children ♀ +	Children ♀ −	Children ♂ +	Children ♂ −	Total
46	+	−	1	1			2
90	+	−		4		2	6
150	+	−		1		1	2
92	−	+		2			2
60	−	−			1		1
74	−	−			1	1	2
88	−	−	1				1
102	−	−	1	1			2

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PROPER NAMES APPLIED TO MEDICO-GENETIC CONDITIONS

CLYDE E. KEELER
The Wistar Institute of Anatomy, Philadelphia, Pa.

A NUMBER of hereditary diseases, syndromes and degenerations described in medical literature often appear under the names of various physicians who have described or investigated them extensively. Persons studying or teaching medico-genetics should be familiar with these proper names as well as with the descriptive appellations of the conditions to which they refer.

For this reason I have listed some of the more commonly employed surnames together with the scientific designations of the diseases to which these apply. To this I have added a few words of explanation and a note regarding what is known about their hereditary transmission.

It must be remembered that what is studied by the medical man as a syndrome entity may actually represent in different families a number of like disease phenotypes (homophenomorphs) indistinguishable except for the fact that they are produced by different gene complexes. Therefore a given disease syndrome may be reported as dominant, or recessive or sex-linked in different families because we are dealing with different causal genes in different families. The mode of inheritance given, has been reported in the literature but this does not preclude the possibility that other modes could, have been, or will be found. But many of the syndromes or diseased conditions described may be brought about also by factors in the environment. Thus, when we say that a certain (non-bacterial) disease is hereditary, we mean that in some families hereditary factors are known to have been the outstanding influence in bringing it about.

Common Synonyms for Medico-genetic Conditions

ABERCROMBIE'S SYNDROME = amyaloid degeneration. Degeneration accompanied by a deposit of lardacein in the tissues. Rare. Possibly not inherited at all.

ADDISON'S DISEASE = metasma suprarenale. A fatal disease caused by hypofunction of the suprarenal glands producing bronzed skin, severe progressive anemia, low blood pressure and digestive disturbances. Rare recessive.

ALBERS-SCHÖNBERG DISEASE = marble bones = osteosclerosis fragilitas. An excessive calcification of the whole skeleton, tending to fill up the blood-forming marrow spaces of the long bones. Recessive and dominant.

ARAN-DUCHENNE DISEASE = bulbar paralysis. A progressive muscular atrophy beginning with the upper extremities. Sporadic. May be rare recessive with a low degree of expressivity. Recessive.

BANNISTER'S DISEASE = angioneurotic oedema. A swelling of the skin due to vasomotor neurosis. Dominant.

BASEDOW'S DISEASE = exophthalmic goitre. Characterized by an enlarged, pulsating thyroid gland, accelerated pulse, bulging eyes, emaciation and increased basal metabolism. Frequently dominant.

BEAUVAIS DISEASE = Chronic articular rheumatism = arthritis deformans. Chronic joint inflammation attended by moderate pain, accompanied by progressive deformity due to hypertrophy and atrophy of cartilege and bone with nodular ossification of the soft structures. Recessive.

BENNETT'S DISEASE = leukemia. A rapid proliferation of white blood cells, together with the enlargement and proliferation of lymphoid tissue in bone marrow, spleen and lymphatic glands. May be rare recessive.

BERTOLOTTI'S SYNDROME = sacralization of the fifth lumbar vertebra. Irregular inheritance.

BIEDL'S SYNDROME = dystrophia adiposogenitalis with atypical retinitis pigmentosa and mental deficiency. Adiposity with genital degeneration, development of the feminine type together with eye and mental changes. Recessive.

BOUVERET'S DISEASE = paroxysmal tachycardia. Recurrent spells of increased heart beat. Dominant.

BRIGHT'S DISEASE = diseases having albumin in the urine. Dominant.

BROCQ'S DISEASE = icterus neonatorum. Jaundice of the newborn probably due to absorption of bile pigments of the meconium. Dominant.

BÜRGER'S DISEASE = thromboangeitis obliterans. Presenile spontaneous gangrene generally in the larger arteries and veins of the lower extremities. Dominant.

CALVE-PERTHES DISEASE = osteochondritis deformans juvenilis coxae. A disease causing atrophy of the head of the femur during growth period, producing a short, thick femur neck and a broad, flat femur head. Dominant.

CAVARE'S DISEASE = familial periodic paralysis. Recessive.

CHARCOT-GUINON DISEASE = dementia complication of progressive muscular atrophy. Recessive.

CHARCOT-MARIE-TOOTH DISEASE = peroneal muscular atrophy. Recessive.

CHRISTIAN'S SYNDROME = diabetes insipidus, exophthalmus and defects of the membranous bones. Dominant.

COOLEY'S DISEASE = erythroblastic anemia = Mediterranean disease. Characterized by the production of inefficient erythroplasts, jaundice, anemia, and increase in blood forming tissue. Simple recessive heredity.

CRUVEILHIER'S DISEASE = progressive muscular atrophy. Degeneration of the ventral horns of the spinal cord. Recessive.

DARIER'S DISEASE = keratosis follicularis. A cornification of the epithelium of the skin characterized by papules from which scabby crusts may be squeezed. Dominant.

DEJERINE-SOTTA'S DISEASE = interstitial hypertrophic neuritis. Inflammation of the connective tissue of a nerve trunk. Recessive.

DELAGE'S DISEASE = dystrophia myotonia. A slow progressive form of muscular atrophy characterized by a delayed relaxation of special muscles. Recessive.

DEVERGIE'S DISEASE = pityriasis rubra. Inflamatory disease of the whole skin. The skin is red and covered with white scales. Often fatal. Irregular dominant.

EDDOWE'S SYNDROME = familial blue sclerotics and fragile bones. Dominant.

ENGEL-RECKLINGHAUSEN DISEASE = Osteitis fibrosa cystica. Bone inflammation with fibrous degeneration and the formation of cysts on the affected bones. Dominant.

ERB-GOLDFLAM DISEASE. Myaesthenia gravis pseudoparalytica—a disease marked by excessive tiring of the voluntary muscles, with a rapid decrease in contractility. Recessive.

ERB-LANDOUZY DISEASE = progressive muscular distrophy. A wasting of the muscles with no lesion in the spinal cord. Recessive.

FÖLING'S DISEASE = idiotie phenylpyrovica. Imbecility having phenylpyrouvic acid in blood and urine. Recessive inheritance. Almost completely confined to Nordics.

FRIEDERICH'S DISEASE = paramyclonus symplex. Recurrent spells of twitching of muscles of the extremities. Recessive.

GAUCHER'S DISEASE = familial splenic anemia. Anemia characterized by Gaucher's cells in the spleen. Recessive (usually found in women).

GILBERT'S DISEASE = pityriasis rosea. Inflammatory skin disease chiefly of the trunk in which there are formed rose-colored squamous macules and circular patches. Irregular dominant.

GOLDSCHLEICHER'S DISEASE = hereditary epidermolysis bullosa. A loosened condition of the epidermis marked by the formation of deep-seated blisters caused by slight friction. Dominant.

GOLDSTEIN'S DISEASE = hereditary telangiectasia with epistaxis. Spider markings due to dilatation of the capillaries and fine arteries with a tendency to nosebleed. Dominant.

GRAEFE'S DISEASE = progressive ophthalmoplegia. An increasing paralysis of the eye muscles. Dominant and recessive.

GRAVE'S DISEASE = exophthalmic goitre. See Basedow's disease. Dominant.

HAMMOND'S DISEASE = athetosis. A derangement characterized by slow recurrent vermicular movements of hands and feet due chiefly to brain lesion. Usually appears in childhood. Multiple factors?

HANOT'S LIVER CIRRHOSIS. Infection of the liver. Recessive.

HIPPEL-LANDAU DISEASE = Angiogliomatosis of the retina. Multiple vascular tumors of neurological origin in the retina of the eye. Irregular dominant.

HIRSCHFELD'S DISEASE = acute diabetes mellitus. A metabolic disease in which the body is unable to store and oxidize the normal amount of carbohydrate due to pancreatic deficiency. It is characterized by excess sugar in both blood and urine, and by the excessive passage of urine. Recessive and irregular dominant.

HIRSCHSPRUNG'S DISEASE = congenital hypertrophic dilatation of the colon. Irregular dominant.

HOFFMANN-WERNIG SYNDROME = precocious hereditary spinal muscular atrophy with hypotonia, paralysis, contracture and atrophy. Recessive.

HOLMES' DEGENERATION. A familial disease having marked motor disorders due to slow cerebellar degeneration usually having its onset between thirty and forty. Recessive.

HUNTINGTON'S DISEASE = Huntington's chorea. Hereditary nervous disease of adults characterized by irregular movements, speech disturbances and dementia. Regular dominant.

KAPOSI'S DISEASE = Xeroderma pigmentosum. A fatal disease of children characterized by dry skin with many brown freckles, ulcerations, muscular and cutaneous atrophy, and spidermarkings that haemorrage badly. Tumors, usually malignant, spring up in great numbers over areas of the skin exposed to light. Recessive.

KLEBS' DISEASE = glomerulonephritis. Inflammation of the coiled blood vessels composing the glomerulus projecting into the capsule of each uriniferous tubule of the kidney. Irregular dominant.

KÖBNER'S DISEASE = Kölner's disease = Goldschleicher's disease.

KÖLNER'S DISEASE = hereditary epidermolysis bullosa. See Goldschleicher's disease. Irregular dominant.

LAENNEC'S LIVER CIRRHOSIS. Infection of the liver. Recessive or multiple factor.

LAURENCE-MOON-BIEDLE SYNDROME = associated obesity, hypogenitalism, retinitis pigmentosa, mental deficiency, skull defects and occasionally syndactyly. Recessive.

LEBER'S DISEASE = hereditary optic atrophy. Degeneration of the retina and optic nerve. Dominant, Recessive and sex-linked.

LEGG'S DISEASE = osteochondritis deformans juvenilis coxæ. Same as Calve-Perthes disease. Dominant.

LINDAU'S DISEASE = haemangioma of cerebellum and retina as a hereditary condition. Dominant.

LOSSEN'S LAW = Affected haemophiliac males do not transmit the disease. Really an error because in Lossen's material no haemophiliac lived to become a father.

MERZBACHER-PELIZAEUS DISEASE = familial centro-lobar sclerosis. Is marked by speech disturbance, muscular incoordination, vermiform movements of hands and feet, rigidity, mental retardation. Recessive.

MILROY'S DISEASE = hereditary oedema of the legs. A swelling due to accumulation of fluid in the tissues of the lower limbs. Dominant with possible a sex-linked modifier.

MOREL-KRAEPELIUS DISEASE = dementia praecox. Adolescent insanity characterized by self absorption and melancholia. Recessive.

NASSE'S LAW. Sex-linkage. Transmitted not only from unaffected women to sons but also from affected males through normal females to some of their male offspring.

NESTLESHIP'S DISEASE = urticaria pigmentosa. A type of infantile rash or hives which marks the skin eruptions with permanent pigment stains. Recessive or multiple factor.

OGUCHI'S DISEASE = congenital night blindness. Defective vision in subdued light. Dominant, recessive, sex-linked varieties.

OLLIER'S DISEASE = achondroplasia. A defect in the formation of cartilege at the ends of the long bones producing dish-faced dwarves with long bodies and large heads but with short arms and legs. Regular dominant.

OPPENHEIM'S DISEASE = congenital myotonia. A condition characterized by tonic spasm and rigidity of certain voluntary muscles when an attempt is made to use them after a period of rest or when mechanically stimulated. Recessive.

OSLER'S DISEASE = hereditary epistaxis with haemorrhagic telangiectasia. Hereditary recurrent nosebleeds with spider markings on the skin having tendency to haemorrhage. Dominant heredity.

PAGET'S DISEASE = osteitis deformans. Osteitis in general is an inflammation of bones; inflammation of haversian spaces, canals and branches and generally of the medullary cavity. Osteitis deformans is a rarifying variety of osteitis with marked distortion of the bones. Dominant.

PARKINSON'S DISEASE = paralysis agitans. Commonly known as shaking palsy. It is a progressive disease of later life. There is a characteristic tremor of the muscles, weakness, delay of voluntary motions and muscular contraction causing peculiar posture of limbs and head and producing a characteristic tendency to change from a walk to a run. Dominant.

PELGER'S NUCLEAR ANOMALY. Pseudoregenerative blood picture. Immature blood cells. Dominant.

PERTHE'S DISEASE = Osteochondritis deformans coxae. Inflammation of hip joint. Dominant.

PICK'S DISEASE = progressive lobar atrophy. A disease of middle life due to atrophy of various parts of the brain with degeneration and loss of ganglion cells of the cerebral cortex. There may be developed a fondness for sweets together with increasing forgetfulness and fits of weeping. Most of the speech is lost, and the hands are usually kept in motion. Dominant.

PRINGLE'S DISEASE = adenoma sebaceum. Benign epithelial tumors of sebaceous gland structure. These form collections of reddish-yellow papules on the face, usually at the sides of the nose and on the cheeks. Dominant.

QUINCKE'S OEDEMA. A localized accumulation of fluid in the skin. Dominant. Sometimes associated sporadically with other allergies.

SCHLATTER'S DISEASE. Degeneration of the tuberositas tibiæ. Recessive or multiple factor.

SUTTON and GULL'S DISEASE = arteriosclerosis. Hardening of the arteries, the extreme of a condition natural to old age. Dominant.

TAY-SACHS DISEASE = amaurotic family idiocy. Disease of infants and children characterized by changes in the macula lutea of the retina, progressive blindness, idiocy followed by death. Found almost exclusively in Jewish people. Recessive in inheritance.

THOMSEN'S DISEASE = paramyatonia congenita, tonic spasm of voluntary muscles when rested or mechanically stimulated. Same as Oppenheim's disease. Recessive. Dominant.

UNVERRICHT'S DISEASE = myclonus epilepsy. Epilepsy in which the intervals of major seizures are characterized by series of quick seizures of appendage muscles especially of the proximal portions. Irregular.

VON RECKLINGHAUSEN'S DISEASE = neuro-

fibromatosis or multiple neurofibroma. Soft connective tissue tumors of the nerve fiber bundles distributed over the entire body and associated with abnormally pigmented areas. Dominant.

VOGTS' SYNDROME = athetosis, oscillation of limbs, spells of laughing and crying due to a lesion of the corpus triatum in the brain. Accompanies various nervous diseases. See Hammond's disease. Multiple factors?

WERLHOF'S DISEASE = purpurea haemorrhagica. A tendency to extravasate blood from various membranes and under the skin to form purple patches. There is a diminution in number of blood platelets. Dominant heredity.

WERNER-SCHULTZ DISEASE = Agranulocytosis. Almost complete absence of granular leukocytes from bone marrow and blood. There are ulcerative lesions with the threat of suffocating attacks. It is usually found in women of middle age and is fatal. Sometimes called glandular fever or agranulocytic angina. Irregular Inheritance.

WHITE'S DISEASE = Same as Darier's disease.

WILLIS-ERB DISEASE = myasthenia gravis. Chronic progressive muscular weakness without atrophy due to bulbo-spinal degeneratian. Recessive.

WILSON'S DISEASE = progressive lenticular degeneration. A disease with bilateral degeneration of the corpus striatum of the brain, cirrhosis of the liver, tremor, spastic contractions, psychic manifestations, weakness, emaciation. Recessive transmission.

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HARVARD SUCCESS AND PARENTHOOD

THE Harvard College Class of 1915, which has conducted its silver anniversary reunion at Cambridge, provides some pertinent data on success.

Fifty of the 600 present survivors of this class (702 matriculated in 1911) have achieved enough success in life to gain recognition in *American Men of Science* and *Who's Who in America*.

These 50 achievers average 2.2 children each. The whole class' average is 1.9 children.

Productive marriages of the achievers have 3.1 children; married members of the whole class 2.3.

Of the 50, 45 have been married. Average marriage age of those 35 who have children was 26.8, without children (10 couples) 30.8. There are 5 bachelors in this special group. The divorce rate of these outstanding men (7:50) has been much higher than that of the whole class (54:600).

As an item of U. S. ecology, the class history shows that 24 of the 50 migrated westward from their birthplaces to achieve success. Seven went eastward. Nineteen flourish near where they were born.

MYRON WEISS

130 West 57
New York, N. Y.

GENETIC STUDIES ON A CAVY SPECIES CROSS

Cavia rufescens (Lund) and *Cavia porcellus* (Linné)

G. v. Ubisch and R. F. Mello*
São Paulo, Brazil

In 1914, J. A. Detlefsen[4] published a paper on the cross *Cavia porcellus* female × *C. rufescens* male, the common domestic guinea-pig and a wild Brazilian species. Ten wild cavies and nearly 1800 hybrids were used for experiments while 600 domestic cavies (guinea-pigs) served as a basis for comparison. Detlefsen's experiments were executed with so much circumspection that a further publication on the same subject would seem unnecessary. However, the fact that he bred the wild species in a climate strange to it imposed some restrictions on his work and left some points unconsidered and others still in doubt. Some of these points are dealt with in this paper, which is inferior to that of Detlefsen except in that it was executed in the native habitat of the wild species.

In this work, done for serological purposes in the Butantan Institute (snake farm), we wanted to compare the faculty of immunization of the wild and domestic guinea-pigs as well as their hybrids with respect to various toxins. Unfortunately, we had only the opportunity to make preliminary experiments with diphtheria and tetanus, and this solely with the pure species and not the hybrids, before the Section of Heredity was dissolved and further experiments were made impossible. Lest all the material be lost, we give here the genetical results of the two years' work, with the limitations imposed by the small number of animals and the short period of work.

Life History of Wild Cavies

Cavia rufescens Lund, called Preá (like all wild cavies in Brazil), is common in the state of São Paulo. The little rodents live in burrows in grass lands. They run very quickly over paths which they make for themselves through the undergrowth and are therefore very difficult to catch. The inhabitants in the interior of the state like to eat them, attributing to them the flavor of chickens. The natives use dogs to catch them, which was not satisfactory for our purpose because the dogs usually injure the preás so that they die in a few days. To catch them unharmed it was necessary to use traps. The Preás have very small stomachs and must constantly feed on fresh plants. For this reason we had difficulty obtaining a sufficient number of animals, as the lazy and untrustworthy boys whom we sent out to do the work frequently let the animals starve in the traps.

During the first few days in captivity the Preás are quite fierce and are capable of leaping as high as one meter. They often injure themselves, especially on the snout, in trying to pass through small holes to regain their liberty. They never become accustomed to human beings and quickly retreat into dark corners of their cages whenever anyone approaches.

In order to keep them healthy for a long period, large, airy cages are necessary. All our animals, both wild and domestic, lived in 50 cm. cubic cages, constructed of wood or limestone with a double floor and a wooden grate through which the excrement could fall. In each was a wooden box filled with alfalfa, with a small opening, in which the animals could hide and sleep. The cages were cleaned every morning, filled with fresh grass, and supplied with fresh water. Care must be taken that preás are not fed moist grass, as when a female gets diarrhea, she always loses her embryos and often dies. At noon they were

*We wish to express our thanks to Miss Charlotte Franke for her help with the English text.

PREA, THE WILD CAVY OF BRAZIL

Figure 8

Photograph of the wild cavy, *Cavia rufescens*. They are plentiful in the state of São Paulo, Brazil, where they live in burrows in grass lands. Unlike the domestic guinea-pig, the Preás are fierce and when angered can leap as high as a meter. The hair standing upright on the neck is characteristic of the species.

fed corn meal, bananas and other fresh fruit, cucumbers, carrots, or sweet potatoes. As the weight of each animal was taken once a week, it was easy to ascertain that varied nutrition is indispensable for the growth of the young and for the health of the adults. They were inspected every day, were separated if they fought or had been injured, and received treatment when necessary. In the subtropical climate of São Paulo care must be taken with wounds as they easily become infected and cause death.

As a rule — in both domestic and wild cavies — two females and one male were placed together in one cage. Sometimes no more than a pair could be kept together and at times even these had to be isolated because they would fight and injure each other. As the best time for fertilizing the females is immediately after the birth of the litter, the males and females cannot be separated before the young are born. We saw no evidence, however, that the males ever hurt the new-born animals. If they are killed and eaten, it is invariably the mother who does so, and then only when they are too premature to live.

The females attain sexual maturity very early. We recorded two births in our experiments when the mothers were

only three months old, and could, therefore, have been no more than one month old when they were bred. We separated the young from their parents when about one month old, and for nearly two months longer kept young males separarate from young females. Premature pregnancy doubtlessly weakens the females, and when they are still small they easily receive injuries in copulation. We always matched the pairs in size and strength and separated the animals whenever they injured each other. We cannot, however, confirm Detlefsen's statement that the wild males at first harassed and bit the tame females almost beyond recognition.

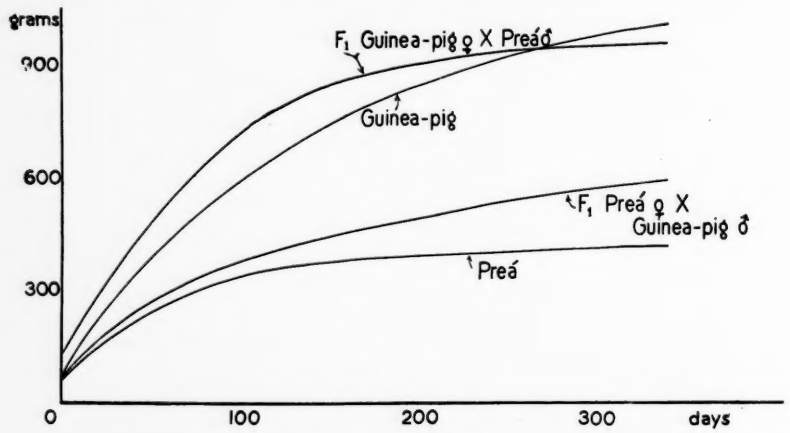
Our first experiments[1,2,8,9] already showed that Preás cannot be immunized with diphtheria antitoxin and that they immunize very irregularly for tetanus. The domestic cavies we used in the first experiments were from our own stock at the Butantan Institute, which were of a mixed type and some of which showed the agouti coat of the Preá, introduced by crosses with the wild species some ten years ago. Since we could never be quite sure that the apparently domestic cavies in this stock did not contain some qualities of the Preás, we eliminated these animals from the immunological experiments and worked with a strain obtained from the Faculty of Medicine, thanks to the kindness of Dr. P. Sawaya, Department of Zoology. There were no agouti cavies in this group, but an examination of the sutures of the skulls, analyzed for the first time by Detlefsen, showed that these cavies also had wild blood. We then wrote to Germany and through the kindness of Professor Kroening, Institute of Zoology in Goettingen, we obtained a variety of cavies that showed no sign of wild characteristics and had already been used for serological experiments.

It was very interesting to note the difference between the Brazilian domestic cavies and the animals from Germany. Our keepers disliked handling the cavies from Germany because they always squeaked when they were touched, whereas the Brazilian domestic cavies could be touched without their uttering a sound. Preás bit and tried to get free, but did not cry. We were planning to replace our hybridized Brazilian domestic cavies with this strain, in which it was certain no wild blood had been infused for centuries, when our section was discontinued.

Interspecific Hybrids

As described by Detlefsen, *C. rufescens* is only about half the size of the common domestic guinea-pig. Its color is agouti — a dark brown with yellow bands—and may vary in different animals. The color of the belly varies from light grey to light yellow. We do not intend to treat coat color and hair from here, since we have nothing to add to Detlefsen's conclusions. Other morphological features and differences from the domestic cavy will be considered in the corresponding paragraphs. During the two years of our experiments 111 wild cavies passed through our hands, 54 females and 57 males. Of these, all were trapped except six males and five females which were born in captivity.

Detlefsen, in his experiments with *C. rufescens,* and Wright with *C. cutleri* always used a wild male and a domestic female in their crosses. Detlefsen writes: "The reciprocal cross (tame male × wild female), was not obtained or even attempted, for it was feared that such small females might die in pregnancy when impregnated by the larger sized guinea-pig male." This fear is unfounded, since the cross produced young of a size normal for the Preá parent, while the young of the tame female × wild male cross were born weighing more than the young of domestic parents. Even if the weight of the embryos were too large for the mother, a smaller number of young in the litter would compensate for the greater weight of the individual embryo, as was shown in the smaller litter of the young domestic cavies. Furthermore, the tame sire impregnates the wild dam much more readily than the wild sire does the tame dam. We obtained viable young 15 times in the cross wild female × tame male with seven different Preá females, and only three times in the cross, tame female



GROWTH CURVES OF CAVY SPECIES AND HYBRIDS

Figure 9

Charts of growth curves in *A* compare Preá, guinea-pig, and their reciprocal hybrids. The large difference in F_1 hybrids in reciprocal crosses seems to depend on the size of the female, as the Preá female has much smaller young.

× wild male: all three with the same Preá male. Other attempts failed, notwithstanding the fact that we made innumerable matings of each type. By restriction in the direction of making the crosses, the difference in the F_1 of Preás and guinea-pigs in reciprocal crosses escaped Detlefsen.

Detlefsen found that the males of the first filial generation are all sterile, and this also holds for the males of ¼ wild blood and for the larger part of those with ⅛ blood. The same result was obtained by us in the reciprocal cross with ½ wild males.

The F_1 females were very fertile and could be crossed with both domestic and wild cavies. Although Detlefsen writes that the cross F_1 females × Preá males was difficult to obtain and that the single ¾ wild female which he obtained out of four ¾ wild matings was sterile, we cannot confirm his results. We obtained the cross F_1 female × Preá male easily and the ¾ wild females also proved to be fertile, although the ¾ wild males were sterile. We must point out, however, that the F_1 females used in these experiments were all of the reciprocal cross Preá female × guinea-pig male, so that it is not certain that the F_1 females of the cross tame female × wild male produce progeny sterile in both sexes.

We proved the fertility of our animals only by crossing them, not by anatomical examination, since we did not wish to hurt our animals by the extirpation of one testicle. We wanted them for serological work, as well as for breeding experiments, and did not like to use animals not entirely normal. After we knew that our work had to be terminated, Dr. José R. Valle of the Section of Endocrinology kindly undertook the examination of the epididymis and the testicles of some ½ and ¾ wild cavies. He found the testicle small and immature, and no spermatozoa in the epididymis. The same test on the Preá male revealed larger testicles and a milky secretion, containing an infinity of spermatozoa, upon cutting the vas deferens.

Besides the ½ and ¾ animals, we also obtained blood dilutions of ¼, ⅛, ⅜ and ⅞ by crossing. Following Detlefsen's plan we use the terms "½, ¼, ¾ and so on wild" only to denote the generation to which the hybrids belong, without implying blending inheritance.

The number of young tame cavies per

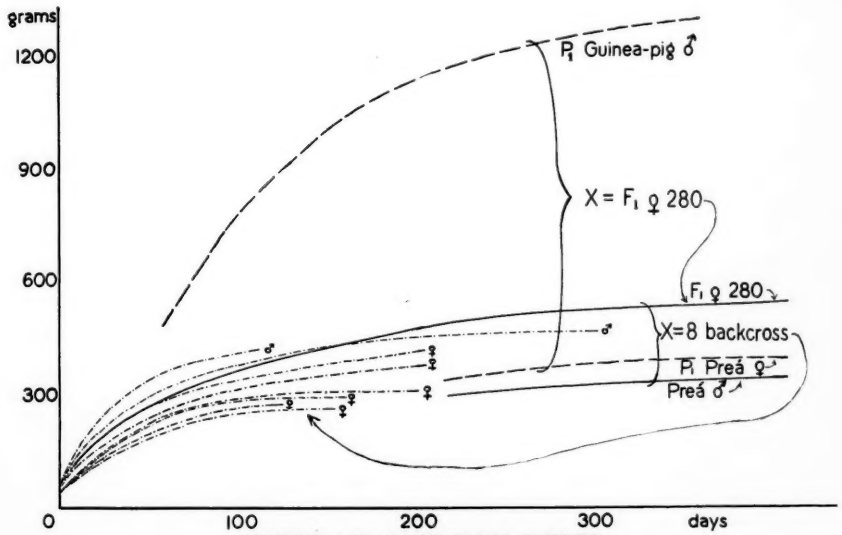


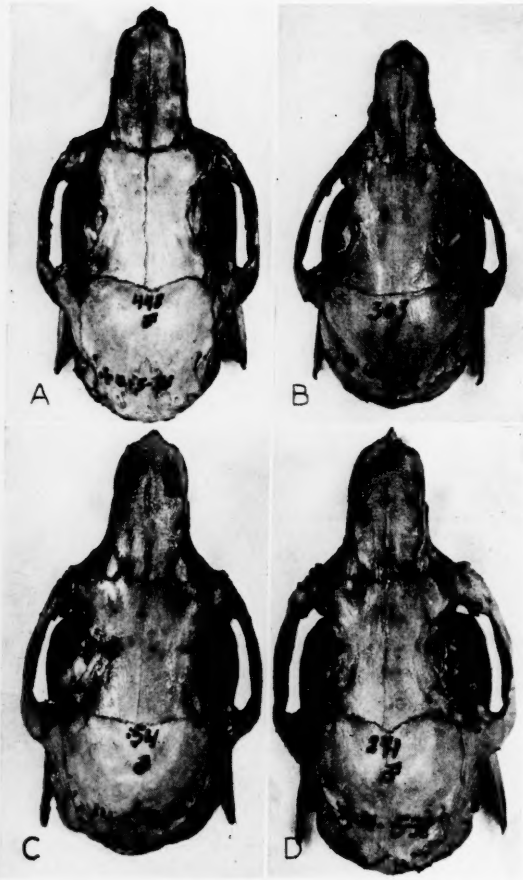
Figure 10

This chart shows the growth curves of eight ¾ Prea backcross young, compared with the growth of their Preá and guinea-pig grandparents. their F_1 hybrid mother, and their Preá sire.

litter varies from one to six, the average number for 170 litters and 436 animals being 2.54. Detlefsen gives an average of 2.34 for 207 litters and 484 animals, and cites Minot with an average of 2.56 for 143 litters and 366 animals. No definite conclusions can be drawn from these numbers, however, since the external conditions are of great importance. Young females, as well as females sired immediately after giving birth to young, produce small litters. It is therefore rather astonishing that our average agrees so closely with those published by Detlefsen and Minot. From the data in Table I, it may be assumed that the litter-size of Preás and hybrids will not be very different from that of the domestic guinea-pig.

The relation between weight and number of young in a litter is given in Table II. Instead of taking the weight at birth we took it on the third day because we did not want to take the new-born cavies out of the cages. There is a remarkable decrease in weight of individual young in a litter of six as compared with a litter of one. The difference would be still greater if the small litters were not mostly from young females. The small number of young from the reciprocal F_1 matings showed a surprising difference in weight. The smallest of the five young from the tame female × wild male cross weighed 155 grams and the largest 200 grams. Such weights never appear in the reciprocal cross and seldom in pure domestic cavies. Many abortions resulted from this cross, presumably because of the weight of the embryos. Table IV[8]* shows the crosses that resulted in abortions.

*The detailed tables and some of the graphs, referred to in the text with a superscript *S*, have been issued by us through Auxiliary Publication, and may be obtained from the nonprofit Bibliofilm Service, care U. S. Department of Agriculture Library, Washington, D. C., by ordering Document No. 1438, remitting 25 cents for copy in microfilm, readably enlarged full-size on reading machine or hand viewer, or $1.50 for copy in the form of paper photoprints readable without mechanical aid.



SKULLS OF WILD AND DOMESTIC CAVIES COMPARED

Figure 11

Photographs of skulls showing the domestic guinea-pig type (*A*), with a backward dip in the frontal-parietal suture and a rough line marking the nasal-frontal suture. In the wild cavy or Preá (*B*) the frontal-parietal suture is straighter, but the nasal-frontal suture has two forward projections. *C* shows the skull of the F_1 from a guinea-pig × Preá cross and *D* shows the skull of a guinea-pig from the Faculty of Medicine at São Paulo. This guinea-pig had smooth, yellow and white hair, but showed by the nasal-frontal suture that Preá blood introduced into the strain many years ago is still present.

Table III shows the range of variation in weight and the average weight of the two cavy species and of their hybrids. We do not give the males and females separately because of the large difference that would be introduced by the small numbers. In every instance the difference between groups is much greater than between the sexes of one species or blood dilution.

The weight of the F_1 hybrid from wild female × tame male cross stands between the species, a little nearer to the Preás. The reciprocal cross stands a little beneath the weights of the tame cavy. The growth curves (Figure 9) show that during the first few months this hybrid is heavier than the tame cavy of the same age, which grows more slowly. but finally exceeds the weight of the hybrid when fully grown. The skulls of the hybrid which we were able to secure were larger than those of the guinea-pigs, which suggests that the greater weight of the eight month old guinea-pigs over that of the hybrid was more a result of fat than size of skeleton. The average of the ¾ wild would be incorrect if calculated as segregation of the unit characters would be expected.

Growth curves were drawn of the weights of young from various cross-

es. As these were quite variable, we give the results of each cross separately, published as a supplement to this paper. Typical curves are shown in Figure 10. We cannot exclude the possibility that with pure lines of tame and of wild cavies we might have obtained somewhat diferent results. The weights of animals first used in the crosses that were not born in our vivarium were calculated. To use the breeding females in our growth curves we always took their weights eight days after they gave birth. This proved to correspond to the weight of a cavy of the same age that had not been pregnant for some months.

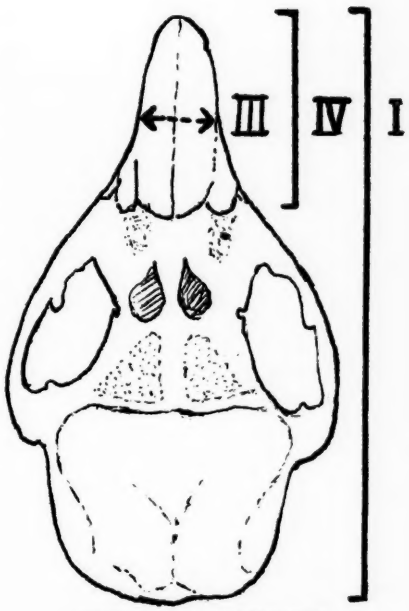
Sexual Cycle

Since it was difficult to obtain all the desired hybrids, we decided to use artificial fertilization. An electrical method was used[6] to obtain ejaculation by applying a 33 volt alternating current three times a minute on the head of the male. As the first condition for applying this method was the exact knowledge of the sexual phase of the female, we initiated a test of the sexual cycle of wild and domestic cavies.

The sexual cycle in domestic cavies varies slightly as regards the number of days, the average being 16 days.[7] The cycle consists of four phases: dioestrum — phase of rest, the interval; prooestrum — phase preceding the phase of sexual activity; oestrum — phase of sexual activity; metaoestrum — return to the period of rest.

The oestrum is easily recognized by making a frottis from the contents of the vagina on an objective slide, fixing it with alcohol and ether and dyeing it with haematoxiline eosine. During this period keratinized cells predominate, while during the other phases leucocytes, mucous, and epithelial cells are present. Table V[s] gives the cycles established by this method with our wild and tame cavies.

We conclude that the period of the sexual cycle which we established for tame cavy agrees with that found by Stockard and Papanicolau. The cycle of the wild cavy is variable, extending from



SKULL MEASUREMENTS

Figure 12

Drawing of a skull of *Cavia rufescens*, showing the spindle-shaped semi-transparent spots on the frontal bones. The numbers show the measurements on the skull which give ratios which represent the difference between the two species and are independent of the size of the skull.

nine to 25 days, which may have been a result of their being unaccustomed to their life in captivity. Domestication disturbs the sexual cycle of many animals. For instance, domestic pigs, goats and sheep may be fertilized at any time, whereas the wild species have well defined seasons of sexual activity. The changes in the sexual cycle as a result of domestication would be a fit subject for further experiments.

Time of Gestation

The oestrum begins immediately after birth and lasts for only a few hours. We can therefore define the time of gestation as the interval between births, when fertilization is affected in the same sexual cycle. Our numbers (Table VI[s]) for the time of gestation are very small be-

cause only continuously pregnant females could be used for them. Our results with *C. rufescens* confirm the numbers obtained by Castle and Wright[3] with another wild cavy species, *C. cutleri*, who found that the time of gestation of wild cavies averages several days less than that of tame species. *C. cutleri* (Wright) varies from 56 to 69 days. In 19 cases he obtained the average of 63.3 days. Our average time of gestation for the tame cavy is 67.2 days while all our numbers for *C. rufescens* and hybrids lie between 62 and 65 days.

Sex Ratio

While wild and tame cavies show almost exactly the mechanical sex ratio of 1:1, it is difficult to draw conclusions from the small number of hybrids. Detlefsen obtained 23 females and 14 males in his crosses of tame cavy female × wild cavy male, from which he concludes that females are in preponderance. Our five hybrids from the same cross were males. We therefore believe that Detlefsen's excess of females and our excess of males are due to the small numbers. The reciprocal cross with seven females and nine males points to equality. Table VII[8] gives the sex ratios we found in Preás, hybrids, and guinea pigs.

Skull Sutures and Dimensions

For a long time differences between the skull sutures of tame and wild cavies have been used as diagnostic characteristics. Detlefsen made the following observation: The suture between the nasal and premaxillary bones and the frontal bones form an *M*. In the tame animals this suture is approximately truncate. The suture between the frontal and parietal bones in the wild is practically a straight line; but in the tame this same suture dips distinctly backward. Detlefsen made drawings of 438 skulls of the wild, tame, and hybrid cavies, and examined several hundred skulls of tame cavies, but he writes "no cases were found which could be confused with the wild."

Detlefsen examined only six wild cavy skulls, so he did not know whether they were variable. He noted that the F_1 hybrids resembled the wild parent; the ¼ wild showed a range of variation from those forms like the ½ wild to forms just like the tame. The ⅛ and 1/16 presented a wide range of forms.

We had the opportunity to examine 75 skulls of Preás, 17 of ½ wild cavies, 10 of ¾ wild, 4 of ¼ wild, one of ⅞ wild, and 117 of domestic guinea-pigs. The wild cavy skulls showed variation, but could never be confused with skulls of guinea-pigs. Of all the hybrid skulls, only one ¼ wild cavy combined the nasofrontal suture of the tame cavy, and the frontal-parietal suture of the wild cavy. All others showed the sutures of the wild cavies.

The skulls of the tame cavies proved to be extremely variable. Twenty-nine of the 117 skulls examined showed transitions to the wild form. These included some from the Butantan stock which was known to include some wild blood brought in by crosses ten years ago. Two cavies that did not react normally to serological experiments provide an example. Upon preparing their skulls (Figure 11) we found that one had intermediary sutures, and that the other closely resembled that of a wild cavy. The domestic cavy, however, whose skull sutures closely resembled the wild type did not come from the Butantan stock, but from the stock of the Faculty of Medicine, showing the absolute necessity of eliminating all Brazilian tame cavies in serological experiments.

The Shape of the Skulls

Besides the form of the sutures, the form of the skulls is variable. The slender nasal bones of the wild cavy make its skull more pointed and "streamlined." We found two proportions to show the difference of the species, namely, the proportion of the total length of the skull from the crista externa occipital to the extreme joint of the nasal (I), the width of the nasal and premaxillary, the narrowest point of the skull (III); and the length of the nasal (IV): the width of the nasal (III). These propor-

tions are independent of the size of the skull, which depends largely on the age of the animal. Tables VIII[s] and IX[s] show that in both cases the ½ wild cavies come nearer to the wild parent than to the tame one. The reciprocal crosses are combined here, as identical results were obtained. The I/III ratio gave an average of 1.89 for guinea-pigs, 2.11 for ½ wild animals, and 2.06 for Preás. The IV/III ratio gave an average of 5.63 for guinea-pigs, 6.25 for ½ wild, and 6.14 for Preás.

Semi-transparent Spots on Frontal Bones

A peculiarity which as far as we know has until now been unknown was noted on the skulls of the wild cavies. These are two semi-transparent spots on the frontal bones beginning near the narrowest place and directed to the anterior point of the skull (Figure 12). They are spindle shaped and sometimes form protrusions which may even be palpable. They are always present in wild cavies and ½ and ¾ wild hybrids, but have never been noticed in tame cavies, which have a stronger and more regular ossification. These thin spots are perhaps one of the causes of the fragility of the Preá, which die frequently from hemorrhage of the head.

Summary

The principal points in Detlefsen's conclusions on the species cross, *Cavia rufescens* (Lund) × *C. porcellus* (Linne) are confirmed. The cross *C. rufescens* female × *C. porcellus* male is easier to obtain than the reciprocal, and results in hybrids whose weight is an average of the two parents. The hybrid young of the reciprocal cross are heavier than the young of the larger parent *C. porcellus*.

The sex ratio in cavies and the cavy

TABLE I. Young per Litter.

Parents	Percentage of Prea Blood		Number of Young per Litter					
			1	2	3	4	5	6
Guinea-pig	0	No. of Litters	35	55	47	27	6	2
Preá	100		7	2	3	1		
Preá♀ × Guinea-pig♂	50		13	1	1			
Guinea-pig♀ × Preá♂	50		1	4	1	1		
F_1♀ × Preá♂	75		4	4	1	2		
F_1♀ × Guinea-pig♂	25		1					
3/4♀ × Preá♂	87.5		3			1		
3/4♀ × Guinea-pig♂	37.5		3					

TABLE II. Relation Between Average Weight (third day) in Grams and Number per Litter

Parents	Number of Animals		Young per Litter					
			1	2	3	4	5	6
Guinea-pig	141	Average Weight	128	117	111	98	83	52
Preá	11		84	75	58			
F_1 (Tame♀ × Wild♂)	5		200	164				
F_1 (Wild♀ × Tame♂)	16		70	68	52			
3/4 Wild	23		112	94	100	68		

Table III. Weight of 8 Months Old Cavies

Parents	Number	Average Wt.--Gr.	Weight in Hectograms									
			2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11+
Guinea-pig	44	888.6±20					2	10	14	8	7	3
Prea	49	393.5±12	3	28	14	2	1	1				
F_1 wild♀×tame♂	15	535 ±15			5	7	3					
F_1 tame♀×wild♂	4	860					1		1	1	1	
3/4 wild	22		2	5	10	3	2					
1/4 wild	4						2	1	1			

hybrids is 1:1. The time of gestation in wild cavies seems to be some days shorter than in domestic ones. The sexual cycle of domestic cavies is about 16 days and in the wild cavies is irregular, ranging from nine to 25 days.

The skull sutures in the wild species agree with the report by Detlefsen. The sutures in the Brazilian domestic cavies are variable, as a result of frequent hybridization with wild cavies.

Two semi-transparent spots are found on the frontal bones of the wild cavy and the hybrids.

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A RECORD-BREAKING "FREEMARTIN"

INTEREST in the recent splendid performance of the Jersey cow Belgrave Aviatrix, owned by Miss Pearl Sales of East Gresford, N.S.W., attaches not only to the magnitude of her production, but also the fact that this cow has upset the theory that a cow, when twin to a bull, does not breed. Belgrave Aviatrix is twin to the bull, Belgrave Aviator.

Not only has Aviatrix produced progeny, five of which have been registered, but now at 10 years she can be credited with yielding 877.5 lb. butterfat in 273 days.

She now becomes the holder of the record for privately owned Jerseys in New South Wales, a position held for many years by Kelvinside Brown Lustre, owned by Mr. A. R. Martin of Wagga, and as recently as January of this year claimed by Mr. F. W. Johnston's Macquarie Luckless 5th.

Miss Sales conducts her own stud at East Gresford, and first took up stud breeding in July, 1939.

In Belgrave Aviatrix can be traced the blood lines of such sires as Wotten Airman (Imp.), Banyule, Airmine, and Some Sultan (Imp.) while her dam is Jersey Mead Peggy 2nd.—Extract from a newsletter issued on June 10, 1940, by the Australian Jersey Herd Society.

DIRECTIVES FOR PRIVATE AND PUBLIC POPULATION POLICY IN NEW ENGLAND*

FREDERICK OSBORN

THERE is one essential requirement for the balanced family which, with an eye to the future, we cannot afford to overlook. There must be an average of something over two and one-half children per married couple in order to replace the population in the next generation. The figure 2.62 is given by Lotka and Dublin[3] and it is neither desirable nor possible to obtain this average by a balance of two- and three-child families. A substantial number of couples will inevitably be childless and others will not have more than one child. The necessary average number can only be attained if at least thirty per cent of all married couples have four or more children.[6] This seems a high proportion of large families to us in this generation. It would not have seemed so to the women who in England were married between 1861 and 1871, of whom three-quarters had families of three or more children with an average of 8.8 children.[1]

A considerable proportion of large families, even if not required for replacement, would still be desirable for other reasons. For instance, it would be desirable that as large a number of children as possible should be born in homes which provided the best opportunity for full development. Similarly, parents likely to hand down genetic endowments superior to the average should have larger than average families.

At present in the United States some 17 per cent of married couples are having more than five children, with an average of seven.[8] These couples who are doing so much more than their share toward replacing the next generation are mainly among the least educated and economically the most deprived couples in this country. Whatever their genetic endowment, and whatever their moral character, they pass on to their children an intellectual atmosphere that must go far offset to all of our attempts at educational advance. It is among just such parents that the birth rate is falling most rapidly at the present time. This is probably as it should be. But since even now the women of the United States are not having enough children to replace their own number in the next generation, it should be our aim to displace the existing type of large family with a new type of large family born to parents not below but above the average educational level. This would be the truly balanced distribution of family size which would make for an unprecedented advance in the cultural level of our people.

Notable changes in the emotional and psychological environment, in interests, attitudes and values, would be necessary to bring about such a new distribution of births. To be permanent, they would have to be accompanied by economic changes, which would make it possible for thoughtful and responsible parents on any economic level to have as many children as they can adequately manage. Only these latter aspects, the economic ones, will be considered in the present paper.

Food a Third of the Budget

Reliable information on the distribution of family expenditures is now available in the Study of Consumer Purchases conducted by a number of government agencies for the years 1935-1936. The average expenditures determined by the National Resources Committee[4] for all

*Paper presented before Session III, Section 3, New England Conference on Tomorrow's Children—July 26, 1940.

types of American families at all income levels are as follows:

Expenditures	*Per cent of total*
Food	33.6%
Housing	17.9
Household operation	11.7
Clothing	10.1
Automobile	8.2
Medical care	4.6
Furnishings	3.4
Recreation	2.9
All other	7.6
	100%

Food is the largest item in the average American budget, twice as large as any other item. In the case of families with a large number of children, its relative importance is even greater. Lorimer and Roback[2] have analyzed the Federal Study of Consumer Purchases by number of children in the family in three selected areas, namely, Chicago, three middle sized cities, and a sample of farm families in Pennsylvania and Ohio. In Chicago, couples with no children spent 31.1 per cent of their income on food as compared to 38.6 per cent spent by couples with three or four children; in the middle sized cities the proportion was 30.2 per cent for couples with no children, and 36.4 for those with 3 or 4, and on the farm 35.8 per cent and 42.8 per cent for those with no children and with 3 or 4 respectively. As the proportion spent for food went up, the proportion spent for all other items (except only clothes) went down. But even in the case of food, the children in the large families were heavily penalized, because there was not enough to go round among so many mouths. Standardized expenditures (or values) per meal per equivalent adult were as follows:

	Couple No children	Couple 1 child	Couple 2 child	Couple 3 or 4 children
Chicago	$.238	$.200	$.170	$.144
Middle cities	.183	.148	.124	.103
Pa.-Ohio farm	.138	.122	.105	.092

Whether on the farm or in the large city, the single child without brother or sister has fifty per cent more spent on his food than the child who is one of three or four. Apparently it is the children in large families who are undernourished, which, in view of the simple arithmetic of the situation, is not surprising. Even a considerable increase in average family incomes would not remedy this situation, because the burden caused by additional children increases more rapidly than it would be possible to increase incomes even under the most favorable circumstances. In the middle cities of the Consumer Purchases Study, the couples with incomes under $2,000.00 a year and those with incomes over $2,000.00 a year had the following:

Standardized Expenditure per Meal per Equivalent Adult

	Couple, no children	Couple, 3 or 4 children
Under $2,000	$.167	$.094
$2,000 and over	.228	.126

These disparities in expenditures for food are just as large for those with incomes over $2,000 as for those with incomes under $2,000. They appear to justify the conclusions reached by the French. The French Family Allowance system, finally codified in July 1939, fixed the minimum current allowance for the third and each succeeding child at 20 per cent of the average wage.[6]

Notwithstanding the greater wealth of this country, it is unlikely that any increase in economic opportunity would make it possible for parents to feed four or more children without a serious loss in level of living as compared to couples without children. Some form of community service seems to be needed if children in large families are to be adequately nourished. The simplest and cheapest solution would seem to be the provision of free lunches to all children at school, providing as far as possible the entire needs of the child in vitamins and protective foods.

The Cost of Adequate Diet

There will be approximately 33 million children between the ages of 5 and 19 in the United States in 1945 and somewhat less in later years.[5,7] At 20 cents a meal for the cost of the food, and with an average of 200 school days in the year, the cost of such a program would reach a total of $1,320,000,000.00 a year. This seems a staggering sum:

but it does not all represent an added expenditure out of our national income. The greater part of it is already being spent in feeding the nation's children at the present time. Insofar as it represents an increase of food to those at present undernourished, it would be an added expense, justified by the improvement in public health which would result. The major part would represent simply a redistribution of the cost of feeding children, so that the whole community would share in the cost, instead of putting, as at present, the whole burden on the backs of the parents of large families. At present large sums are being spent by the government in the attempt to destroy or subsidize the export of surplus farm commodities. A more reasonable use of this money would be to use it to feed the nation's undernourished children.

The second largest item in the American family budget is housing. It averages about 20 per cent of total family expenditures. The Lorimer and Roback[2] study indicates that when there are several children the demands for food are usually so pressing that less, rather than more, money is spent on housing. The added number of children go into the same or a smaller number of rooms. Such a situation must deter many thoughtful and responsible parents from having more than one or two children. Some way must be found to remedy this situation. But even a system under which additional rooms could be provided for extra children free of charge, would leave unsolved other aspects of present urban housing conditions which offer serious impediments to family life.

If housing is to meet the needs of family life, construction must be planned from the start with a view to creating in every residence area communities designed for children and family life; in which schools and playgrounds can be reached without crossing heavy traffic; in which clinics and day nurseries are an integral part of the community; in which cooperative activities reduce the cost and labor of rearing children. Such a eugenic ideal of housing would require careful planning and a new understanding of modern problems. In the operation of planned and well coordinated facilities there would be room for real economies as compared to the loss of time and effort in rearing children under present conditions.

Other Deterrents

In addition to the major items of food and housing, there are a number of smaller items acting as deterrents to parenthood which we can list as follows:

1. The high cost of medical care, particularly for the middle income groups of society, constitutes a restraining threat and fear upon parents who would like to have large families. All feasible measures that may reduce this possible or actual cost of medical care to responsible parents with large families should be adopted.

2. The working woman, whether in the factory or in the professions, should not be so heavily penalized for having children. Maternity leaves should be granted without loss of job. Present arbitrary rules against employing married women have no social justification.

3. Unquestionably the high cost of a suitable education for children is a restraining factor in the case of many responsible parents. Suitable provision should be made in all public school systems (grade, high school and state college) for children whose development is beyond that of the average child so that responsible parents, opposed to the retardation of such children to the average rate of development, would not feel forced to send their children to private schools. Examination of public school systems generally reveals that much can be accomplished in relation to this objective by reorganization, rather than expansion, of present educational facilities.

4. Post-graduate students, and all highly trained professional young people should be put in a situation where marriage and children would be possible at a reasonably early age. This could be accomplished by moderate financial aid combined with changed living conditions,

and, most of all, with a change in the psychological atmosphere.

Decisions as to size of family, when made on a voluntary basis, will depend on factors springing from the psychological environment, and on the emotions, interests and life-values of the parents. These psychological factors deserve special and separate treatment. But in the long run, they can only find expression if economic conditions are such as to make this realization possible. Since children are no longer an economic asset, we must envisage the need for basic changes in the form and extent of community services, so as to make it possible for thoughtful and responsible parents on any economic level to have as many children as they can adequately manage. Unless such changes are made, this country will either continue to make its major population replacement on an involuntary basis from its most isolated, most ignorant, and least responsible parents, or else will fail to replace its own numbers thirty per cent or more a generation.

New needs bring new solutions. Proposals for population policy such as those now under consideration appear radical only because they are novel. Actually they are conservative in the truest sense, as all efforts to preserve and strengthen the family are conservative.

Some of these proposals represent simply a reorientation of existing social efforts. Others involve a new expense to be borne by the community and by the state and federal governments. Proposals involving new expenses deserve a critical reception in these days when there have been unprecedented drains on the public treasury, often at the demand of entrenched minorities. But the preservation of the family and the renewal of the race on a voluntary basis, and from among the country's responsible parents, are needs so basic that they seem to take precedence over almost all others. In filling these needs we would be enlisting the self sacrificing effort of all those interested in the country's children, now and in the future.

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MARRIAGE RECORD OF ALUMNAE FOR THE FIRST CENTURY OF A COEDUCATIONAL COLLEGE

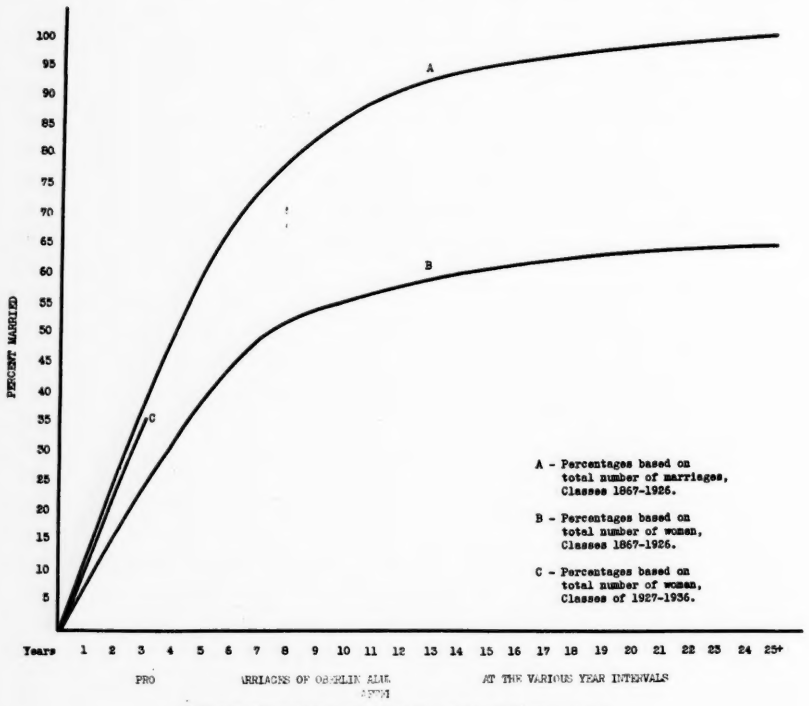
LOUIS D. HARTSON
Oberlin College

DATA are now available in the Alumni Records Office of Oberlin College which make possible a review of the marriage statistics for the alumnae for the first century of coeducation in a single institution. The total number of women to receive the first degree upon graduation from The College of Arts and Sciences, of Oberlin College, to and including 1936 (when the data were gathered for the last alumni catalogue), is 5,550. Returns are on file for 98 per cent of this total. Acknowledgment for keeping in touch with the graduates to so extraordinary a degree, so far as it can be credited to any one individual, is due to Secretary Emeritus George M. Jones and his staff in the Alumni Records Office. The final report is of December 31, 1939. Hence the shortest interval since graduation, that for the class of 1936, is three and a half years.

Table I summarizes data by decades with reference to the gross numbers and the proportions who have married. It indicates the figures for the women still living, so far as recorded on December 31, 1939.* Examination of the seventh column shows that there was a steady decline in the marriage rate during the first sixty years, from almost 100 per cent to 58 per cent, but that for those who graduated in the twenty-year interval between 1907 and 1926 the proportion has risen to 65 per cent. The lowest record was that of the class of 1899, of whose women members only 45.3 per cent have married. Evidence which has accumulated during the last decade indicates that the marriage rate is on the increase. This is shown by the figures in Table II, which reports the data for the period 1917 through 1936. Of the women in the classes of 1928 and 1929, over 73 per cent have married. Inasmuch as ten per cent or more of the women marry (for the first time) after they have been out of college more than nine years, it is to be expected that the proportion who ultimately marry, for the more recent alumnae, will be between seventy and seventy-five per cent.

Tabulation has been made for the entire group of 3,589 women of the interval between graduation and marriage. A comparison of the data for the different decades shows (1) the shortest interval occurred in the experience of the women of the first decade, when 55 per cent of the marriages occurred within the first year. (2) Although, in the second decade, 1847-1856, the proportion of the marriages which occurred during the first year dropped to 28, this was also a distinctly greater incidence than has appeared in any later decade. (3) The decade, 1857-1866, shows some irregularities that were probably caused by the Civil War. (4) The curves for the six decades covering the period, 1867-1926, display about the same characteristics. They have therefore been combined and are shown as Curve *A* in Figure 13. Dur-

*Explanation of a slight discrepancy between figures reported in this table and those in Table I of the article "Marriage Statistics for Oberlin Alumnae" *The Journal of Heredity*, XIX, p. 228, is in order. In the case of three of the decades it was discovered that the class lists had included some duplicate entries, due to the fact that some who first received the "literary degree" were later granted the A.B., and in the last decade additional names had been added through the practice of accrediting individuals to the class with which they did most of their work when the degree was granted at a later date than the year indicated.



PROPORTIONS OF ALUMNAE MARRYING

Figure 13

In the classes graduating between 1867 and 1926 about two-thirds (65%) of the alumnae married, — over half of them within five years of graduation. The recent graduates (*C*) marry sooner on the average than those who graduated earlier (line *C* compares with line *B*).

ing this period (a) the average interval between graduation and marriage was four years; (b) the annual increments are approximately the same for the first four years (12.5, 12.5, 13, and 12), after which the curve flattens off until, (c) by the twelfth year all except eight per cent of the marriages will have occurred.

Curve *B*, in Figure 13, represents the proportions of the total number of women of the decades, 1867-1926, who married at the various intervals after graduation indicated on the abscissa. Even though it is not possible to tell the entire story for the women of the most recent decade, the facts are in for the first three years after graduation. These indicate a trend toward reduction of the interval between graduation and marriage. Whereas Curve *B* shows 8, 8, and 8.5 per cent of the total number of women for the period 1867-1926 marrying in the first, second, and third years, respectively, the corresponding proportions for the decade, 1927-1936, are 11, 13, and 11. This total of 35 per cent for the first three years may also be compared with a total of 28 for the decade, 1917-1926, and 23 per cent for the decade, 1907-1916. The proportions for the decade group, 1927-1936, are represented by Curve *C*.

The implication contained in the last paragraph to the effect that there is a decided tendency for marriages to occur at earlier ages than was formerly the case is confirmed by the figures in the last column of Table I, which is based

upon actual age statistics. Marriage is occurring, on the average, a year or two earlier than was the case forty years ago.

The earlier Oberlin study, referred to above, reported a significant difference in longevity in favor of the unmarried women. Table I gives the figures by decades as of December 31, 1939. A distinct break in the table appears with the year 1897. Since that date there has been a slightly larger mortality among the unmarried women. The proportion still living among the married women is 95.3, and among the unmarried women, 92.7. This difference is probably not statistically reliable. In the case of the older women, however, there is a marked difference in favor of those who are unmarried. The proportion of the unmarried women for the years, 1867-1896, now living is 59.2, whereas that for the married women is but 43.7. The greatest contrast appears in the case of the women for the decade, 1887-1896, where the difference between the proportions still living is 27 per cent, which is just the differential found a decade earlier when comparison was made between these groups. This seems to suggest that, until the period of the last forty years, marriage provided certain peculiar life hazards, but that during the present century this distinctive hazard has not been present, at least in the case of Oberlin alumnae.

As some articles have emphasized the contrast that once existed between the marriage rates of the coeducational and the separate women's colleges, and as some of the reports from women's colleges have been based upon incomplete questionnaire returns, analyses have been made of the data available in the official registers of representative institutions and the figures have been grouped for comparable time intervals. For instance, the statistical summaries printed in the *One Hundred Year Biographical Directory* of Mount Holyoke College were based upon a 75 per cent return from the living alumnae. Helen Butts Correll's* recent report of marriage and birth data for the Wellesley alumnae was based upon returns from but 58.7 per cent of those to whom questionnaires were sent. The data used in this study were obtained from the official alumnae registers of the various institutions. The statistical reports published in the Barnard register were based upon a 76.6 per cent coverage of the alumnae, and those in the Bryn Mawr register, 47 per cent coverage. In the case of Goucher, Mount Holyoke, Radcliffe, Vassar and Wellesley, an estimate was made from the registers by checking through class by class, tallying the names of the single women for whom no information was available. In all these cases the coverage was approximately 99 per cent.

Examination of Table III shows (1) that the proportion of college women graduates who marry is on the increase in the case of each of the colleges from which data were obtained. Data from two of the women's colleges (Vassar and Wellesley) indicate that of the women who had been out of college between 12 and 21 years, 73 per cent were married. The Correll report for Wellesley puts the figure, for those who had been out 12 to 16 years, at 78 per cent. This computation, made in 1935, was based upon a 54 per cent return for the students of these particular classes. The Register of Wellesley College Alumnae, of 1938, reports the marital status of 99.3 per cent of the members of these classes, 1919-1923. Of this group 73 per cent were married. Inasmuch as the interval between graduation and the time of report was more than two years longer in this instance than when Miss Correll's report was made, it is apparent that her figure of 78 per cent is a bit higher than the true figure for the group in question.

(2) Inasmuch as the colleges showing the highest marriage rates are those with the most complete data, and as all the colleges display a rise in the marriage rate, it seems reasonable to conclude that more complete returns would produce

*Correll, Helen Butts. The Birth Rate for Wellesley College Graduates. *Jour. Hered.* 30:137-138. 1939.

confirmatory evidence on this point.

(3) It is no longer the case that the coeducational colleges (if Oberlin is representative) can be set over against the women's colleges as a class, on the basis of marriage figures. Some of the women's colleges report marriage ratios that are higher, and some ratios that are lower than that which is found in the case of the coeducational college. This suggests the question as to what proportion of the marriages in a coeducational college involve the men of that institution.

Table I also reports the numbers and proportions of Oberlin alumnae who married Oberlin men (alumni or former students). Of the total of 3,589 marriages here represented, 1,245, or 35 per cent, were with Oberlin men. In the initial decade nearly two-thirds of the women married college associates; for the next forty years the proportion was about 46 per cent; during the last fifty years the proportion has dropped to between one-third and one-quarter. The fact that the figure for the last decade, 32 per cent, is larger than that for the one immediately preceding, 25 per cent, probably does not indicate a real rise in the curve, since later marriages among more recent alumnae will probably represent an increasing ratio of non-Oberlin men.

TABLE I. Number and Proportion of Oberlin Alumnae Married; Proportion of Single and Married Women Living December 31, 1939; Proportion Marrying Oberlin Men; and Mean Age at Marriage.

	NUMBER						PERCENT				
Classes	Total Alumnae	Married	Single	Married Living in 1939	Single Living in 1939	Married Oberlin Men	Married	Married Living in 1939	Single Living in 1939	Married Oberlin Men	M. Age at Marriage
1837-46	80	78	2	0	0	51	97.5	0	0	65	26.9
1847-56	129	104	25	0	0	45	80.6	0	0	43	29.1
1857-66	276	215	61	1	0	104	77.9	0.5	0	48	28.2
1867-76	218	150	68	13	11	67	68.8	8.7	16.2	45	29.0
1877-86	282	199	83	86	33	93	70.6	43.2	39.8	47	28.4
1887-96	378	242	136	159	126	100	64.0	65.7	92.6	41	29.7
1897-06	497	287	210	239	167	108	57.7	83.3	79.5	38	29.2
1907-16	1033	672	361	619	318	210	65.1	92.1	88.2	31	28.9
1917-26	1350	873	477	854	454	220	64.7	97.8	95.2	25	27.4
1927-36	1307	792	515	788	510	310	60.6	99.5	99.1	32	25.1

TABLE II. Marriage Figures of Oberlin Alumnae for the Classes, 1917 - 1936.

Classes	Total Alumnae	Married No.	Married %
1917	115	66	57.4
1918	131	84	64.1
1919	101	65	64.4
1920	134	92	68.7
1921	133	81	60.9
1922	138	87	63.0
1923	162	115	71.0
1924	149	91	61.1
1925	158	102	64.6
1926	129	90	69.8
1927	158	108	68.4
1928	157	115	73.2
1929	127	84	73.2
1930	147	96	65.3
1931	124	76	61.3
1932	120	74	61.7
1933	107	66	61.7
1934	139	63	45.3
1935	109	60	55.0
1936	119	50	42.0

TABLE III. Percentages of Alumnae of the Colleges Listed Who Have Married.

Decade	OBERLIN	BARNARD	BRYN MAWR	GOUCHER	MOUNT HOLYOKE	RADCLIFFE	VASSAR	WELLESLEY
1837-46	97.5				75.7			
1847-56	80.6				71.0			
1857-66	77.9				61.5			
1867-76	68.8				57.5		56.4	
1877-86	70.6				57.4		55.1	51.8
1887-96	64.0		51.5		50.3	45.9	53.4	49.0
1897-06	57.7	53.0	57.3	62.0	54.4	51.1	62.4	57.0
1907-16	65.1	59.8	66.1	59.3	57.5	51.4	70.0	66.5
1917-26	64.7	61.1	72.6	63.9	57.8	58.7	73.5	71.5
1927-36	60.6		50.9	41.3	39.1	52.8	60.7	49.4

DIFFERENTIAL FERTILITY IN THE WHITE POPULATION IN EARLY AMERICA

A. J. JAFFE
U. S. Census Bureau

CONSIDERABLE information is now available about the various differentials in the birth rate in the United States and in Western Europe during the twentieth century.* In general, two facts have been established: (1) There are marked differentials between urban and rural areas, and (2) there are marked differentials among socio-economic classes.

As to the universality of these phenomena, however, comparatively little is known. It is suspected that differences in the fertility of the socio-economic classes became important only with the growth of our modern industrial urban culture.[8] Our knowledge of the existence or nature of differential fertility in cultures other than our own is indeed slight.

With these thoughts in mind, it seemed worth while to attempt to discover what differentials in fertility may have existed in the United States before large-scale industrial and urban development had begun. The Industrial Revolution was already in progress by the time this Nation was founded, but its influence in the early part of the nineteenth century was still relatively slight as compared with the influence of industrialization today.

Data and Method

The basic population data were all obtained from published volumes of the United States Census from 1800 through 1840. In the period 1800-1820 inclusive, only two age groups were presented, 16-24 and 25-44. The number of females under one year of age was not available at these periods; only the number under 10 was presented. In order to estimate the number under one, the following procedure was adopted: For each state the proportion which those under 5 constituted of those under 10 was available for 1830. This proportion was then applied to the number under 10 prior to 1830 and thus the number under 5 was estimated. One-fifth of this number was then taken as an approximation to the number under one.

Beginning with 1830, data were available for four age groups, 15-19, 20-29, 30-39, 40-49. In addition, the number of females under 5 was available. These were then divided by 5 in order to approximate the number under one.

It will be seen from these age distributions that the rates computed are of such a nature that allowances have already been made for mortality during the first 2½ years of life.

In order to compute the "gross" reproduction rates on which this study is based, it is necessary to have age-specific birth rates. These, however, were not available. Instead, the indirect method that has been so extensively applied by Dr. Karpinos[4] was used. This calls for sample age-specific fertility rates. Accordingly, the age-specific rates for 1920 in each state were applied to the population data for the same state in these earlier years.

From the above discussion the limitations of this analysis should be apparent. The standardized reproduction rate used here obviously is not exact. At best it is but an approximation, the size of whose deviation from the true figure is unknown. When we consider the con-

*For a general summary see the various articles in *The Annals of the American Academy of Political and Social Science*, Vol. 188, November, 1936. See also chapters 4 and 5 of the Resources Committee Report[9] ("Regional and Racial Differences in Reproduction Rates," and Kiser, C. V., "Social Conditions Affecting Birth Rates.")

sistency of the differentials presented below, it seems quite safe, however, to conclude that differentials in these standardized rates are significant, even though the absolute rates themselves may be in error.

Results

The index of fertility employed here is the standardized number of female children under one year of age per woman (as computed from the enumerated number of children in the Census reports). This index would be exactly the same as the gross reproduction rate if the number of births had been used instead of the number of children under one. Since data for converting the number of infants under one year of age into the number of live births are almost entirely lacking, it was thought best not to make this conversion. For the sake of convenience, however, this rate will be referred to in the following discussion as the "gross" rate.

Ideally, the net reproduction rate should have been used, but this calls for reliable life tables. At present, such tables are not available; hence it was necessary to use this standardized rate, which is less than the gross—but greater than the net—reproduction rate.

Geographical Differentials. In 1800 the states having the lowest "gross" reproduction rates were those along the Atlantic seaboard, particularly in lower New England. In the Middle Atlantic States, the Carolinas, and upper New England the rates were somewhat higher. Finally, in the inland states stretching from the Lakes to the Gulf, the rates were highest. Briefly, the picture is that of a series of birth rates making a pattern of concentric semicircles with the low rate center along the northern section of the Atlantic coast line.* (Fig. 14)

Urban - Rural Differentials. The "gross" reproduction rates were calculated for the white population in every state in the Union from 1800 to 1830. Within each state separate rates were calculated for the rural areas and for cities, which were grouped according to size.

The picture for the entire United States in 1800 is as follows: If the "gross" reproduction rate in the rural areas is assumed to equal 100, that of cities under 10,000 is 70, that of cities of 10,000-25,000 is 57, that of cities of 25,000-50,000 is 62, and that of New York, the only city over 50,000, is 64.†

The results for New York State for 1800 appear as follows: If the reproduction rate for the rural areas be stated as 100, the rate for cities under 10,000 is 87 and that for New York City (population about 60,000), 64. In Massachusetts almost identical differentials were observed. With the rural areas set equal to 100, the cities under 10,000 had a rate of 86 and Boston, a city of 25,000, a rate of 68. Similar differentials existed in the South. In South Carolina, Charleston (about 19,000 population) had a rate only 61 per cent of that of the rural areas (Table I).

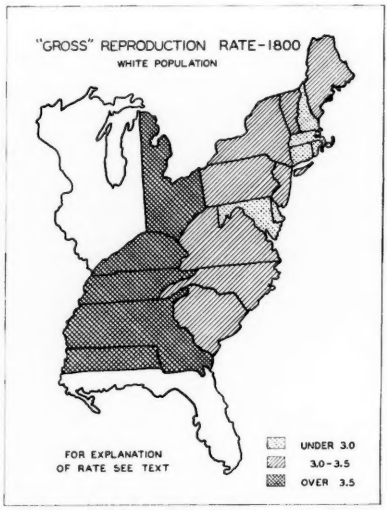
These differentials between the urban and rural areas are found in each state and territory, through 1810, 1820, 1830, and subsequent years. These findings are in agreement with those of other investigators.[10]

Differentials according to Plane of Living. Ten separate observations were possible on differentials in fertility in the white population according to planes of living (Table II).

For studying differentials among urban groups, data were available for three cities, New York, Boston, and Providence. For New York City in 1820

*Resources Committee Report,[9] p. 124. Here are presented data on the number of white children under 5 per 1000 white women aged 15-49. When plotted on a map, these data form about the same pattern as that described in the present article.

†The pattern for the entire United States is not as regular as might be desired, mainly because of the inclusion (in these national figures) of areas with a heterogeneous variety of social conditions, as found in the various states. When the urban-rural differentials are computed for each state separately, there appears a regular pattern of decreasing rates as urbanization increases.



BIRTH DIFFERENTIALS IN 1800
Figure 14

Early in the history of the United States, differences in the "gross" reproduction rate were already evident, with the highest rates in the most recently settled areas.

data were obtained from the New York State Census of 1821,[7] which reported for each ward in the city, the number of white males 21 years of age and over who owned property worth more than $250. It was thus possible to compute the proportion of all white males in each ward who were in this property-owning class. The wards of the city were then divided into three groups, the first having a minimum proportion of large property owners, the third group having a maximum proportion, and the middle group an intermediate proportion. "Gross" reproduction rates were calculated for the three groups of wards with the following results: Setting the "gross" reproduction rate in the wards with the minimum proportion of persons owning property worth more than $250 as equal to 100, we obtain a rate of 82 for the intermediate group and 80 for the group of wards having the maximum proportion of large property owners.

In 1840, data relating to the amount of personal property in each ward (as obtained from the city tax records[1]) were available. The wards of the city were divided into four groups according to the amount of personal property per capita. Computing "gross" reproduction rates and setting the wards with the minimum amount of property as equal to 100, we obtain the following: for the second class 83, for the third class 73, and for the group of wards containing the largest amount of property per capita, 57.

In Boston (1830) data were found in the tax records regarding the amount of real and of personal property owned by persons living in the various wards.[6] Setting the "gross" reproduction rate in the wards with the minimum amount of property per capita as equal to 100, the "gross" reproduction rate index was 85 in the intermediate wards and 58 in the wards having the greatest amount of property per capita.

In the studies just mentioned, the wards of the city, rather than the individuals, were distributed according to economic level. For the city of Providence, Rhode Island, in 1830 a tax record book[5] was available which could be matched with the original 1830 Census schedules. This made possible the allocation of individual households in Providence to three levels: First, those which had so little real and personal property as to escape taxation; second, those which had less than $3,000 worth of property, and third, those which had more than $3,000 worth of property. Two sets of "gross" reproduction rates could then be computed, one based on the total number of women in each of these three classes and the other based on the number of married women living with their husbands. Calling the "gross" reproduction rate for all women in households having no wealth 100, we obtain a "gross" reproduction index of 95 in the intermediate group and of 72 in the highest group.

It was thought advisable to investigate differentials for married women separately, on the assumption that some of the differentials observed between classes

might be due to the inclusion of large numbers of maids and servants in the households of the richer classes. Calculating the "gross" reproduction rate* for married women alone, it was thought, would eliminate this disturbing factor. Only two classes for married women could be set up in Providence, households having no wealth and those reporting themselves as having some wealth. If the "gross" reproduction rate in the first class is said to equal 100, the index figure for the propertied class was 79.

For the rural sections of the country, data were also available for studying differentials according to plane of living. From the New York State Census of 1821 figures were at hand on the amount of agricultural land and of livestock in each county. On this basis the rural counties could be placed in three groups: Those in which there was a minimum of agricultural land and of livestock per person ten years of age or over; counties in which there was a maximum, and counties in which there was an intermediate amount. Setting the "gross" reproduction rate of the counties with the least land and livestock as equal to 100, we obtain a rate of 95 for the intermediate group and a rate of 86 for the highest group.

For Southern counties the only index of plane of living was that of slave ownership. The counties in North Carolina and Georgia in 1800 and 1820 were divided into three separate groups for each state: those with lowest, intermediate, and highest proportions of slaves. Differentials almost equal to those in the Northern cities were found in these states at both periods. In North Carolina in 1800, for example, setting the "gross" reproduction rate in the counties with the smallest proportions of slaves as equal to 100 gives us a rate of 88 in the intermediate group and a rate of 76 in the group of counties having highest slave ownership.

In South Carolina in 1800 the same index of plane of living was used—that of slave ownership—but the counties were divided into four groups. Again setting the "gross" reproduction rate in the counties with the lowest proportion of slaves as equal to 100, we obtain a rate of 89 for the second group, 83 for the third group, and 66 for the rural counties with the highest proportion of slaves. It should be noted that in the South there probably were few white female servants to affect the comparison between the wealthier and poorer groups of counties (Table II).

TABLE I.—Standardized Reproduction Rates of the White Population by Urban-Rural Residence, United States and Selected States, 1800[a]

Area	Standardized Reproduction Rate	Area	Standardized Reproduction Rate
United States		Rhode Island	
Rural	100	Rural	100
Cities 2,500-10,000	70	Cities 2,500-10,000	69
" 10,000-25,000	57		
" 25,000-50,000	62	Pennsylvania	
" 50,000 and over	64	Rural	100
		Cities 2,500-10,000	85
New York State		Philadelphia[b]	57
Rural	100		
Cities 2,500-10,000	87	Virginia	
New York City[b]	64	Rural	100
		Cities 2,500-10,000	69
Massachusetts			
Rural	100	South Carolina	
Cities 2,500-10,000	86	Rural	100
Boston[c]	68	Charleston[d]	61

[a] For sources of data and explanation of "standardized reproduction rate," see text.
[b] Pop. 60,515. [c] Pop. 24,937. [d] Pop. 11,220. [e] Pop. 18,824

TABLE II.—Standardized Reproduction Rates of the White Population, by Plane of Living, for Selected Geographical Areas in the United States: 1800-1840[a]

Area, date, and plane of living	Standardized Reproduction Rate	Area, date, and plane of living	Standardized Reproduction Rate
Urban areas:		Rural areas:	
New York City, 1820		New York State, 1820	
Lowest	100	Lowest	100
Intermediate	82	Intermediate	95
Highest	80	Highest	86
New York City, 1840		North Carolina, 1800	
Lowest	100	Lowest	100
Intermediate low	83	Intermediate	88
Intermediate high	73	Highest	76
Highest	57		
		North Carolina, 1820	
Boston, 1830		Lowest	100
Lowest	100	Intermediate	85
Intermediate	85	Highest	79
Highest	58		
		Georgia, 1800	
Providence, 1830		Lowest	100
Lowest	100	Intermediate	86
Intermediate	95	Highest	86
Highest	72		
		Georgia, 1820	
Providence, 1830		Lowest	100
(married women)		Intermediate	92
Lowest	100	Highest	85
Highest	79		
		South Carolina, 1800	
		Lowest	100
		Intermediate low	89
		Intermediate high	83
		Highest	66

[a] For source of data and explanation of "standardized reproduction rate," see text.

*The "gross" reproduction rate for married women may be interpreted as the answer to the following question: If all women were married at age 15 and had the age-specific marital fertility rates existing at the date of the investigation, to how many female children would they give birth by the time they reached 45? No allowances for mortality are made. (See also a forthcoming paper on this subject by Dr. B. D. Karpinos.)

Implications of the Foregoing

One of the most important implications of these results lies in the fact that these differentials existed prior to the introduction of modern contraceptive practices. Some population students have held that present differentials in the birth rate have arisen from the uneven distribution of modern contraceptive knowledge and technique, for example, Grotjahn.[2] They then suggest that in time the techniques will become evenly diffused, after which differentials in the birth rate will be nonexistent. The findings of Dr. Himes[3] in this connection are of interest. He has shown how all cultures at all times have had various techniques of contraception. The differentials reported in the present study are of such magnitude that they seem to validate Dr. Himes' findings regarding the prevalence of contraceptive techniques in early America.

The second implication of these findings, it would appear, is that these differentials had already existed for a long time; that is, they were too great at the beginning of the nineteenth century to have originated then. Although the data presented are not conclusive, it is likely that fertility differentials were as large at the beginning of the nineteenth century as they are today. Consequently, it may well be assumed that they had been in existence since the beginning of the eighteenth century, if not earlier, for a culture would take some time—at least three or four generations—to develop such differentials.

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THE LARGER ASPECTS OF MATERNAL CARE*

FRED L. ADAIR, M.D.
Professor of Obstetrics and Gynecology, University of Chicago

THE Maternal Care Movement has as its main actuating motif the preservation of life and the prevention and correction of conditions which lead to the disability or death of mothers and their babies. Frequently we are wont to consider mainly the urgent immediate elements of such a program and to forget or even fail to recognize some of the fundamental objectives which are essential to the ultimate attainment of such a goal. In its broader aspects such a program is basic to the attainment of those beliefs and institutions which are characteristic of our American democracy. In proportion as our mothers are healthy and happy may we expect that our babies will be brought up to realize to the fullest the promise of an equality of opportunity for life, liberty and pursuit of happiness. It is our belief that there are two fundamental objectives which are closely coordinated and essential to the attainment of these goals: without proper physical, intellectual, and psychical health, there is no satisfactory education and without such education about ourselves there cannot be optimal health. Thus it is clear that the broad implications of the Maternal Care Movement are geared directly into some of the most fundamental problems of the development of a better human society. The story of the past as well as history in the making today, tragedies of the individual as well as of groups and of nations, personal experiences, and national and world cataclysms, bring forcibly to mind the importance of having fewer abnormal human beings, and more normal and superior personalities.

Democracy and civilization do not want persons with perverted ideas and behavior. Our form of government requires an abundance of normal, socially and humanistically minded individuals among its citizens, people whose minds and whose hearts are dedicated to advancement not only of national but of international welfare. The foundations of the past, laid by our ancestors, and the structures of the present, reared by our fathers, are today exposed to stresses and strains which lead many to despair of the future. We are setting out from this structure of the past to build the bridges into the future over which those yet to be born must travel into the unfolding world of their lives. It is for us to see that they will not collapse and be swept away by the rising torrents of fear, ignorance, and indifference to suffering and to the higher values, which threaten us today from many quarters. The future depends largely upon what is done now. It is important for those of us who believe in our nation and in its institutions to recognize that the mothers and their babies are the first and last line of defense. We are determined that no one from within or from without our country shall interfere or dictate the course of development of our institutions. We have no desire to hinder other people who believe in different types of development so long as they interfere in no way with our peace and our freedom. It is a truism that our mothers and babies shall be defended to the last trench in war: we sometimes forget they must also be defended in peace. We must devote our hearts and our brains to protect them from slaugh-

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ter by the failure of leaders to understand and eliminate the fundamental causes of war, or by the development of ruthless dictatorial powers, which demand the right to thrust us into the jaws of death to no useful or hopeful end.

The laws of heredity and environment are the most potent factors in the life of any individual. As long ago as 1803 Buchan excellently summed up the importance of the environmental factors in child welfare in his "Advice to Mothers." He wrote:

> The rules laid down are practical in every condition except that of cheerless poverty. With the hope of removing this exception, I shall point out the most effectual method of assisting women so circumstanced; and I do not know any manner in which humanity, charity and patriotism can be more laudably exerted or even a part of the public revenue more usefully employed than in enabling mothers to bring up a healthy and a hardy race of man, fit to earn their livelihood by useful employments and to defend their country in the hour of danger.
>
> The more I reflect on the situation of a mother the more I am struck with the extent of her powers and the inestimable value of her services. Mothers not only create but sustain their creation and hold its future destiny in their hands: every man is what his mother has made him and to her he must be indebted for the greatest blessing in life, a healthy and vigorous constitution.
>
> It must be understood that by a mother I do not mean the woman who merely brings a child into the world but her who faithfully discharges the duties of a parent—whose chief concern is the well being of her infant and who feels all her cares amply repaid by its growth and activity. No subsequent endeavors can remedy or correct the evils occasioned by a mother's negligence and the skill of the physician is exerted in vain to mend what she through ignorance or inattention may have unfortunately marred.

We now realize that the laws of heredity as well as the effects of environment are at least coordinately potent factors in determining the life-pattern of any individual. To Buchan's "rules laid down" the far-sighted mother must add a consideration of the heredity of the father. While the father contributes equally with the mother to the genetic inheritance of their children, he can have only an indirect influence on pre-natal development through furnishing the mother an optimal environment during the intrauterine life of the fetus. The newborn, the early and later infant and childhood life are also largely influenced by maternal environment. Doubtless hers is the most powerful and lasting influence which affects the development of our bodies, of our minds and of our characters. Thus the mothers of necessity contribute more than an equal share to the development of "a healthy and hardy race of men."

Years ago, measured by the individual duration of life, but minutes ago in terms of the development of the human race, the idea was set forth that all men are created free and equal. Free doubtless in our continent so far as human contacts and nature's laws permit, but, while politically equal in theory at least, they certainly are not equally endowed physically, mentally or psychologically. We could all agree that among us everyone should be freed of avoidable hereditary and environmental handicaps so that all could have as nearly as possible an equal opportunity and a fair start in life.

We all recognize this ideal in our sports, which are governed by rules drawn to enable us to compete on a fair basis with an umpire to punish violations. In civil life we are ruled by laws and customs with the courts acting as the umpires. Unfortunately, the laws are not always equitable and they sometimes work unfairly. Nor are our judges always unbiased. Government is an experiment and there are few valid controls; democracy is being tried and is slowly advancing toward the goal of equal opportunity and a maximum of happiness and freedom for all.

This introduction may seem far afield from the objectives of this Congress. If one considers carefully what maternal care means the purpose of these few comments is apparent. The basis of our life is founded on equal opportunity for every one of us and the future of our institutions and country depends upon the development of equality for all mothers and their babies. Without minimal essential opportunities for the development of every new-born citizen it is impossible to assess the genetic worth of

any of us. The accomplishment of our objectives will ultimately involve the control of both hereditary and environmental influences, all of which are yet incompletely understood. Time will bring added knowledge but in the meantime we have much to do in securing universal application of the knowledge we already have.

It has been conclusively proved that an increasingly wide-spread application ot the knowledge we now possess to the care of mothers and their babies can, and has, reduced our national, state, and local mortality rates. However, it is necessary to emphasize again and again that a reduction of the mortality rates is only a partial answer to the problem. Death is a very concrete criterion, and we can draw some definite conclusions from a study of who dies and who is spared. The mortality rate is also an index of a larger morbidity rate which is of tremendous importance. Much disability and a shortened life for many mothers or their babies can be charged to the lack of proper obstetric care. Death is the natural sequence of life and all individual physical life terminates after a specified cycle. The causes of death are partly environmental, but heredity also plays an important part in determining when, and of what, we fall ill and die. While we live, health is most desirable and no one person and no society can look with equanimity upon lives marred by avoidable illness or the tragedy of premature death. We need to know more about these two factors in developing a well rounded and humane maternal welfare program.

The groups represented here are primarily concerned with health and with health education. The discussions and the data presented at this Congress have conveyed certain information to us and to the public through the press and the open public meetings. These data may be classified into the following categories:

(1) The present status of our knowledge about the mother, the fetus, and the newborn; the present methods of applying this knowledge for the benefit of all; the revealing of possible errors and of definite gaps in our existing knowledge and the discussion of ways and means to eliminate these errors and to discover the proper approach to the solution of unsolved problems.

(2) There is the tremendous task of selecting the best methods of applying our present knowledge and of determining how it can be made universally available. In passing it may be well to observe that certain fundamental principles are well established and essential to the success of any plan,—methodology or technic of application may vary, but the basic principles remain unaltered. For example, no one could today deny the necessity for clean aseptic deliveries though there are still differences of opinion as to the best means of preventing puerperal infection.

(3) The groups represented here are doctors, nurses, public and voluntary health agencies, institutions for medical and nursing service and for education. Our common objectives are those that pertain to the welfare of women, chiefly mothers, and the babies, especially the newborn. Our objectives are ultimately the same though our approach, viewpoints and methods of solution may differ. It is vital that we agree on fundamental principles, even though our methods of application may vary. We could all doubtless agree that care of mothers and babies which is adequate to conserve individual and community health and life is essential. What then are the fundamental principles which are necessary for adequate maternal and infant care?

Preconceptional Care the Next Step

We believe that preconceptional care is basic, and in using this term I should like to stress the point that preconceptional care is a preparation for conception and for reproduction.

In discussing preconceptional care we cannot avoid a consideration of both eugenic and euthenic viewpoints. This type of care is not only maternal but also paternal. In fact, it is both parental and ancestral. Proper reproduction may

not be so vital for the individual, but it is paramount for the survival and success of the human race. We have much to learn about heredity, especially of its application to the human. We must move slowly but surely in applying the laws of heredity to the control of human reproduction, but certainly where the parents, particularly the mother, offer both a bad heredity and poor environment to the progeny, some method of artificial selection and control would seem advisable. Hereditary factors should receive proper consideration in evaluating the ultimate outcome of a future conception. The proper preparation for future propagation begins at or before birth, as the health of future parents influences that of the progeny. The prevention of diseases which interfere with skeletal and other tissue growth and with development of body and brain is essential.

The prophylactic measures which minimize the incidence and seriousness of organ and tissue-damaging infectious diseases must be universally applied not only to maintain the health of the individual but also in the interest of the future family and community. In the field of preconceptional care the study and elimination of genes fated to thwart the normal development of organs and tissues appears as a sound and necessary extension of the same principle.

In the development of a sound preconceptional program, the adolescent period in development is one of prime importance. This difficult age, with its accompanying phenomena and problems, is one for which the individual, the family and the community should have a sympathetic appreciation. There must have been both antecedent education and character building of the maturing persons, thus enabling them to withstand the biologic shock of this rapidly developing aspect of life. Habit forming of various kinds is to be avoided, especially the various forms of drug habits which are often detrimental to the individual and may be harmful to germ plasm. Illicit relations and pregnancies constitute important biologic and social problems which no generation has yet solved satisfactorily. Sane biologic education, character building and the establishment of proper family ties seem to offer the best approach for the solving of this biologic equation. These matters are closely related to venereal disease control, the solution of which problem is being vigorously attacked from many angles, one of which is that of maternal care.

This brings us to a most important phase of preconceptional care, the necessity of which has long been recognized by some in order to safeguard the health and lives of the coming generation and preserve the family. Premarital examination is an answer to many questions which arise in the minds of individuals contemplating marriage. Intelligent and careful examination and advice to these young persons will avoid many a contagion which might damage or kill a future baby, thus preventing a situation which might disrupt the family. Much good can be done at this time in pointing out the existence of hereditary disabilities or weaknesses which might make the birth and rearing of normal children impossible.

The prospective family will be safeguarded medically, economically, and sociologically. Legislation, even if enforcement is attempted, will not be completely successful without intelligent and wholehearted cooperation of both professional and lay groups. There must be a good understanding of the underlying principles and objectives, and of the benefits to be derived. Many unhappy lives and disrupted homes can be avoided by these relatively simple medical and social preventive measures.

The period of growth and development is vital, as the fetus, newborn, infant and child must have in addition to the materials essential for maintenance, those substances fundamental for growth. Growth is a process which is affected by both hereditary and environmental factors. Growth and development do not follow a straight line but a jagged one because of spurts which occur at various epochs in the life cycle. If essential fac-

tors are lacking at crucial periods an arrest of growth may occur which cannot be compensated later. This means a permanent lack of optimal development. Interference with skeletal development and subsequent bony deformity due to lack of certain nutritive elements and of proper hygiene is one of the most striking illustrations which is obvious even to the casual observer. It is curious but nevertheless true that the availability of the essentials is not the only difficulty encountered in securing proper hygiene, food, etc., for mothers and infants. Habits and customs have such a strong hold upon our lives that many follow them blindly in spite of their obvious errors, even though the proper hygiene and food are accessible.

The problems then are not always simple and people have to be not only educated but re-educated. It is essential not only to remove factors leading to erroneous living but also to introduce a program of right living.

It might just as well be recognized that all persons are not well adapted for parenthood. In some instances reproductive life may be detrimental to a woman and hasten the inevitable end of her life. Under other circumstances the infant itself may be a poor product and be useless or harmful to itself and to others.

It is also well known that fertility differs greatly in different persons and that some individuals are incapable of reproduction. This may be a great tragedy in their lives. Many can be made fertile—some remain sterile. Probably the greatest tragedy in a woman's life is the rejection of an opportunity to have a baby, as a result of which she acquires a permanent sterility but retains a longing for a subsequent childbirth. Much can be done now to cure infertility and more will be learned in the future.

Prenatal care involves more than medical and nursing attention as many sociologic and economic factors are related which doctors and nurses cannot solve. They, as well as others, need compensation for their work and unfortunately our present unbalanced economic system places many of our citizens in a marginal or submarginal economic status. How these various difficulties can best be overcome no one has yet proved. An ultimate solution is essential and progress toward this goal must be made as rapidly as possible. Adjustments in our economic and sociologic life which will promote education and health among us are vital for the continuation of our democratic institutions and our liberty. It can be reiterated that the success or failure of our civilization depends largely upon our ability to progressively improve our mothers and babies physically, intellectually and psychologically. This depends largely upon continuity of progress and plans. One step leads to another and prenatal care is followed by delivery care. It is impossible to state the details of maternal care at this time but it is important to bring about a situation where every mother receives it in her home, in the clinic, or in the hospital as circumstances require.

Care of mothers and babies should be a continuous process, each step leading inevitably to the next. The problem is greater than doctors and nurses alone can solve. It will require the cooperative effort of doctors, nurses, health workers, educators, scientists, administrators, sociologists, publicists and the public to solve the problems surrounding human reproduction. Both private and public funds will be required to carry on generally and successfully the necessary programs for proper care.

In a broad sense our problem is both biological and sociological and it cannot be solved in the face of conflict between these fundamental sciences, but only by cooperative understanding and effort.

The program of safeguarding these lives is much broader than its medical and nursing aspects. It has ethical, economic and sociologic bases which can only be established and soundly developed by proper evaluation of all its factors and by cooperation among all those elements in the community which can be enlisted in the fight to save rather than to destroy life. The enlistment is for the duration of this long war for the defense of mother and child.

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PREFACE TO EUGENICS

By FREDERICK OSBORN

Can arbitrary control of human breeding be entrusted to arbitrary power? To what extent is democracy necessary as a safeguard to a eugenic policy? What kind of a population policy should be adopted by the United States? What are the implications of a eugenic form of society for the bearing and education of children and for various forms of social organization? These are just a few of the important matters discussed by the distinguished author of this significant new volume. *This is the September Selection of the Scientific Book Club.*

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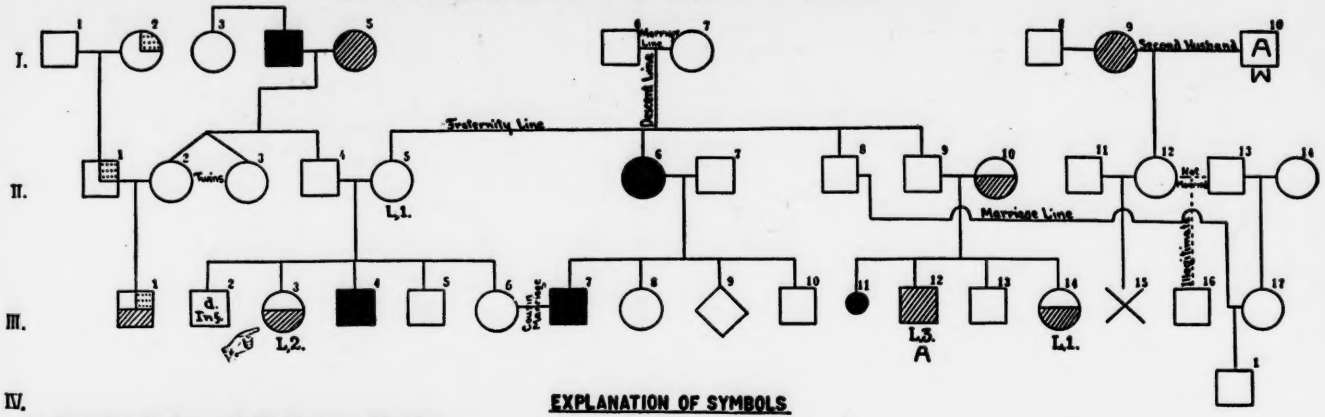
SAMPLE PEDIGREE CHART SHOWING THE MANNER OF CONSTRUCTION, AND THE USE OF STANDARD AND SPECIAL SYMBOLS.



EXPLANATION OF SYMBOLS

(a). Standard for all Pedigree Charts:

□=Male; ○=Female; ◇=Sex unknown; ●=Still-birth or Miscarriage; X=Children — number and sex unknown; ○○=Twins; d. Inf.=Died in Infancy; ☞ Points to the Propositus or central figure in the pedigree.

□—○=Parents.

□○□○○=Children.

Roman figures to the left indicate generations; Arabic figures locate individuals, (thus III. 7 is the young man in the third generation who married his cousin).

The following letters, placed in or around the individual's pedigree symbol, are standard for certain traits: A, alcoholic; B, blind; D, deaf; E, epileptic; F, feebleminded; I, insane; M, migraineous; N, normal in reference to traits under consideration; Ne, neurotic; P, paralytic; Sx, sexually immoral; S, syphilitic; T, tuberculous; W, wanderer.

(b). Especially devised or selected for this particular pedigree-chart:

■ ● = Successful leaders in politics. ◱ ◷ = Extra thumb on right hand. L.1. = Highly successful author. L.3. = Little or no ability in literary efforts. ▨ ◍ = Superior in vocal music. ▨ ◍ = Medium attainment in vocal music.

To fit the particular family and traits (whether physical, mental or temperamental; good or bad) under consideration, invent special symbols, or select special letters (in addition to those standardized under (a) above) to be placed within or near the particular individual's pedigree symbol, to indicate particular traits and their degree of development.

Prepared by the International Commission of Eugenics. See *Journal of Heredity* for August 1926. Additional copies may be obtained from A.G.A.

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